THE ENGINEERING MAGAZINE

THE WORLD IS ITS FIELD

VOL. XXXIX. SEPTEMBER, 1910. No. 6.

THE ROUTING DIAGRAM AS A BASIS FOR LAYING OUT INDUSTRIAL PLANTS.

By Charles Day.

Mr. Day's article is an important part of the systematic and comprehensive study of the "Planning and Building of Industrial Plants" which was begun in THE ENGINEERING MAGAZINE a year ago, and was continued by the analysis of "Machine-Tool Equipment for Metal-Working Plants" presented in our June and July issues. The entire series, enlarged, adapted and revised, will soon be published in book form.—THE EDITORS.

THE primary purpose of this article is to call attention to the advantages that can be derived from the use of the graphical routing diagram as a basis for the planning of industrial plants. This diagram, as its name implies, indicates the paths or routes followed by the materials of manufacture when passing from their crude to their finished state, and in its final development it absolutely defines the plant in all particulars of layout.

Many industrial plants are seriously handicapped through the fact that the *arrangement* of their departments and equipment imposes operating expenses that are almost prohibitive. If errors are made in the selection of certain machines or other detail features, they can usually be corrected at comparatively small expense. On the other hand, if the arrangement of departments and equipment, and therefore the character of the buildings, has been incorrectly solved, the resulting plant may be such as practically to prohibit the establishment of correct conditions unless a very great monetary loss is incurred. It is becoming generally appreciated that this is a question deserving the utmost consideration, and as the efficiency of a given plant is governed primarily by the *manner* in which its layout is worked out, a method that has been found to be sound would appear to merit considerable attention.

The first step when preparing to lay out an industrial plant is, of course, to become thoroughly conversant with all the manufac-

turing requirements imposed by the particular business to be housed. This phase of the subject was discussed at considerable length in a series of papers entitled "The Planning and Building of Industrial Plants," published in THE ENGINEERING MAGAZINE September to December, 1909. When working up the layout, it is of primary importance that all these detail factors should be considered collectively so that their inter-relationships can be properly discerned. The graphical method allows of this more readily than any other.

Figure 1 is presented as an illustration of the routing diagram in its most elemental form. It pertains to a series of conditions not particularly unlike those very frequently presented. In the upper left-hand corner is shown in plan a factory used exclusively for the manufacture of pianos. All the buildings, except the one marked with the letter "F," were in existence at the time the work was undertaken. The object in view was the establishment of conditions more favorable to economical manufacture of pianos than were afforded by the existing layout, which was the result of a growth extending over many years but not in accordance with any definite plan for the ultimate development. In addition, a very material increase in output was to be provided for. The product consisted of pianos of both grand and upright types, but for the purpose of simplicity the lines on the diagram have been drawn in for grand pianos only.

A grand piano is composed of a number of principal units, only seven of which we need consider. The essential parts of five of these, viz.; the top, rast, rast bracing, rim, and keyboard, are made of lumber and so start in their crude shape at the lumber pile. The plates are made of metal, and in this case the preliminary operations were performed in a shop not a part of the group of buildings in question. The sounding boards were also made at another shop. The location of the main lumber storage was originally as shown on the plan, but the disposition of the space in buildings D, C, B and E was quite different from that indicated. The first diagram prepared showed as accurately as was possible the manner in which the materials progressed through the plant at the time of the initial investigations, and a study of this diagram formed the basis for a series of revised layouts. These showed the paths of travel in two directions only, from floor to floor and in a direction parallel to the front property line, as it was necessary to establish broad relationships before taking up the routing in detail. The floor space required for the estimated increase in output was approximated and, as buildings D, C, B and E were satisfactory for general manufacturing purposes, it was found to be practicable to dispose of their

floors in a manner best adapted to the routing of the product. The studies showed the desirability of extending the plant at the point indicated on the plan by building F. Finally, diagrams showing the various floors in plan were prepared, but insofar as is allowed by a diagram showing routing in elevation only, the final arrangement is shown by Figure 1. The sequence of the principal operations is indicated as well as the points where the various units are assembled.

While a diagram which is carried out in no greater detail than Figure 1 gives comparatively little information that is of specific value as a basis for the design of buildings and installation of equipment, yet it is a *key* to the manufacturing problems as a whole and a useful and, in fact, a necessary step toward the final solution.

When decisions have been reached as to the areas of departments, their general arrangement, and whether or not they must be located on the ground floor, and when the necessary trucking and railroad facilities have been defined and a site tentatively chosen, a more advanced form of routing diagram can be prepared than was illustrated by Figure 1. If the building is of the single-story type, the routing can be satisfactorily shown in a manner indicated by Figure 6, but if the buildings are multiple-story this method requires the preparation of wholly separate diagrams for each floor and the advantages of graphical representations are not nearly so pronounced.

Figure 3* exemplifies the proper manner of recording graphically the routing of the product in multiple-story buildings. Of course, in actual practice the same result can be approximated through showing the floors in outline perspective as in Figure 4, leaving out the building detail. Diagrams of this character should be made prior to locating individual machines and, in fact, they become the guide for the performance of this work. The departments need to be considered individually only when locating machine equipment, and the routing diagrams showing the progress of materials from machine to machine represent the last step to which the work can be carried.

We will now consider the principal factors which brought about the diagram illustrated by Figure 3. In this case the plant indicated by the perspective comprises entirely new buildings to accommodate a business formerly conducted in another factory. The broad requirements for which the plant was laid out were a daily output of 150 dozen rough stiff hats, 300 dozen finished stiff hats, 100 dozen rough soft hats, and 150 dozen finished soft hats, making 700 dozen or 8,400 hats per day. It should be explained that rough hats are made by certain manufacturers for customers who desire to perform the

* Fig. 3 is a folding insert facing page 816.

finishing operations themselves. These finishing operations comprise, for stiff hats, operations 29 to 42 and for soft hats, 21 to 31 inclusive (see Figure 3). It will not be necessary to consider all of the operations individually. The preparation of the chart required only such knowledge concerning the detail methods employed as was necessary to give a thorough understanding of the manner in which hats are made. The problem primarily was to plan a factory that would immediately provide for the output of hats specified above and also provide for reasonable growth of departments.

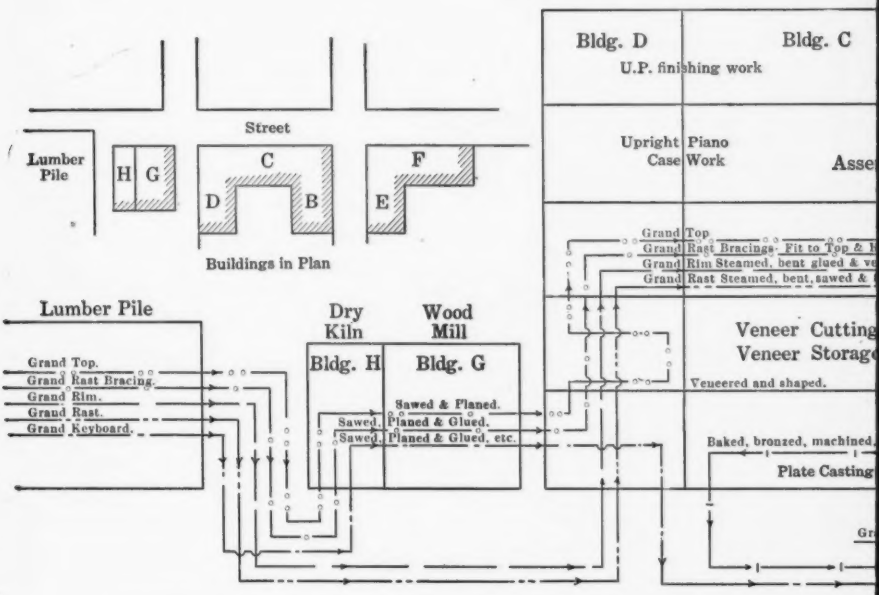
The preliminary routing studies revealed the fact that the work of the manufacturer comprises three clearly defined series of operations: first, those dealing with the skins from which the fur is obtained for making the hats, including the removal and preparation of the fur; second, the forming and shaping of the hat body up to a point where the "rough" hat is produced; and third, the finishing operations that must be performed upon the rough hat body in order to bring about the final product.

The first series of operations comprises operations 1 to 4 inclusive for both soft and stiff hats. Operations 2, 3, and 4 represent in each case a series of distinct processes performed in part by labor but principally by special machinery. After the fur and hair have been cut from the skin, it is imperative that it should not come in contact with water. Further, the blowing which is done for the purpose of removing the hair from the fur is performed in machines made up of a series of compartments into which air is blown and, owing to the speed at which the fans operate, a reasonably substantial foundation is required. As the blowing equipment occupies a very considerable part of the total space required for the performance of the operations in question, the nature of the enclosure used to house them should be suited primarily to the requirements imposed by it. In this case it was decided to arrange the blowers in series of twelve sections, running parallel and across the building.

The second series of operations comprises numbers 5 to 28 inclusive, which are characterized by the fact that the principal processes in this group are effected through the alternate wetting and drying of the product from which the hats are made. Operation 6 forms the loose dry fur into the felt body which is the first definite form assumed by the product when making stiff or soft hats (Figure 2). This is accomplished by feeding the fur, which has been previously weighed, into the top of a cylindrical shell about 4 feet in diameter and 5 feet high, at the bottom of which is a rotating table that carries a finely perforated copper cone about 24 inches in

Buildings F and E Showing Bridge to Building B

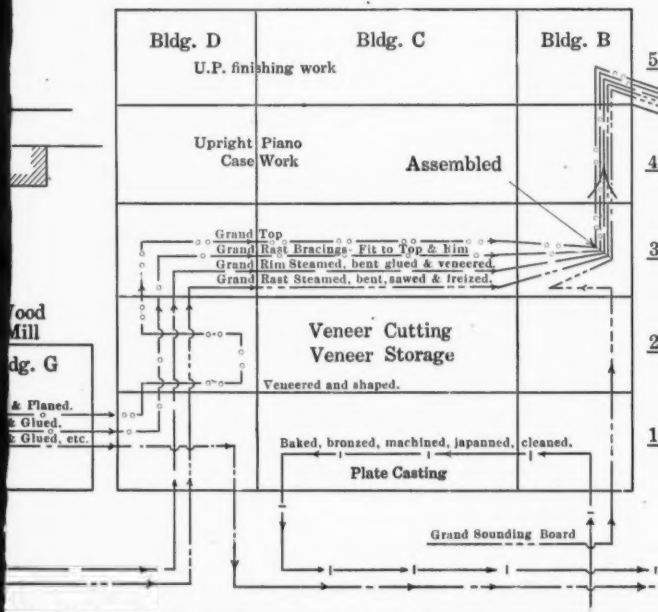
Action Department Second Floor Building F



ELEMENTARY FORM OF ROUTING DIAGRAM (IN ELEVATION) SHOWING SEQUENCE IN PRIN
GRAPHIC REPRESENTATION OF ROU

Action Department Second Floor Building F

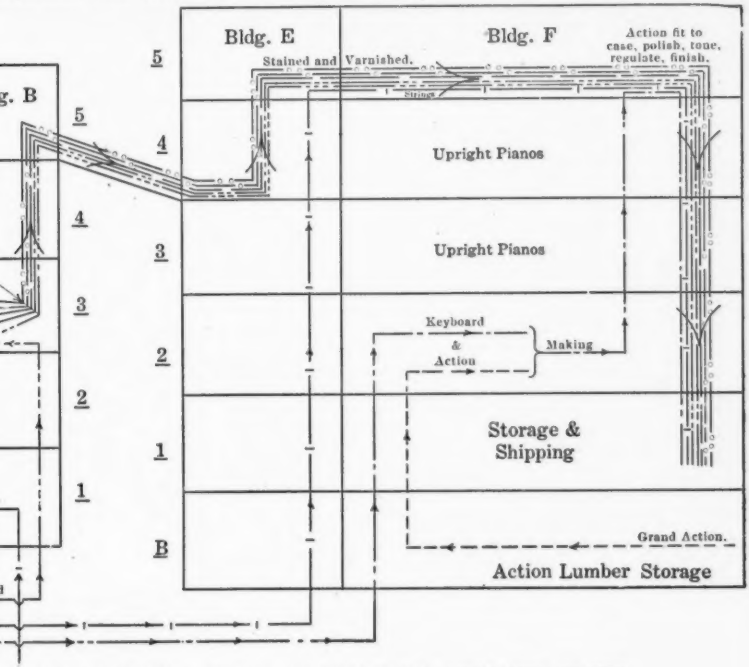
Finishing Department



RAM (IN ELEVATION) SHOWING SEQUENCE IN PRINCIPAL OPERATIONS ON GR
GRAPHIC REPRESENTATION OF ROUTING TO AN INDUSTRIAL

Department Fifth Floor Building F

Building F which was the Addition to the Plant



ONS ON GRAND PIANOS. THIS IS AN ELEMENTARY APPLICATION OF THE NDUSTRIAL PROBLEM.

height. The fur entering the cylinder in a finely divided state is deposited against this copper cone by means of the suction created by an exhaust fan, which draws the air through the perforations and down through an opening in the spindle of the rotating table. The rotary motion is only for the purpose of assuring the deposit of a uniform layer of fur upon the cone. When the requisite amount of fur has been so deposited, the cylindrical shell is opened, wet cloths are wrapped around the cylinder to hold the fur in place, and it is then lowered into a tank of hot water. This dipping starts up the felting action which is the basic principle upon which the manufacture of hats of this kind depends. Each individual fibre of the fur shows, under microscopic examination, numerous small barbs. The individual fibres are worked together by the interlocking of these barbs during the immersions in hot water and the subsequent hardening and sizing processes, which merely consist in *working* or *kneading* the hat bodies upon a bench or in machines.

This group of operations contains the stiffening processes, numbers 15, 16, 17, and 18, which in reality form a distinct sub-group by themselves. The presence of large quantities of alcohol introduces a considerable fire hazard and, in addition, the equipment required for this work necessitates special building features. Except for these stiffening operations, it will be seen that the processes of the second group merely subject the felt body to a series of gradual changes in shape in a manner that necessitates repeated water immersions. Therefore, the work is characterized by the fact that large amounts of very hot water are used, requiring special provision for drainage and ventilation and calling for complete segregation from the first and third series of operations, in connection with which the complete absence of water is a necessity. Another feature pertaining to this part of the work is that all the product passing through the processes just referred to is upon stock orders rather than upon customers' orders and, while this condition might not prevail in another hat factory, it was an established practice in this instance.

Operations 29 to 44 for the stiff hats and 21 to 33 for the soft hats are all performed through the medium of dry heat—at least, those that have to do with changing the form of the crown or brim. Further, whereas the hats are made for stock orders during the second series of operations and can be stacked in piles one over the other, so requiring very little room for storage between operations, during the third series they are made for customers' orders and must be handled in much smaller lots; and as the crowns have been formed they must be stored individually in special racks provided for the

purpose. Consequently, when in transit they occupy a large amount of floor space as compared with that needed prior to the formation of the rough hat body.

Several diagrams were prepared before the final one illustrated by Figure 3 was produced. It will be seen that a separate building is provided for the first series of operations, including also the first operation of the second series, viz., the forming and hardening of the hat body. Operation 6 is housed in the same building as operations 1 to 5, because the fur should be carried the least distance possible between blowing and forming, and also because a structure suitable for the installation of blowing machines is adapted also for the comparatively heavy forming equipment. Further, these two types of equipment require the major portion of the power needed for the entire plant; so, as the direct drive had been decided upon, it was considered advisable to locate them in as close proximity as possible and near the engine room. There are no industrial objections to the use of a multiple-story building for these operations; in fact, a study of the diagram will show that such a structure has certain advantages; consequently a three-story building was adopted.

The requirements of the operations comprising the second group, exclusive of the stiffening processes, were such as to make a single-story building with adequate roof ventilation and floor drainage preferable. The locations of the various departments were worked out with a view to minimizing the travel of the hat bodies and at the same time making possible the use of but one dry room serving both stiff and soft hats. It will be seen that the dry room is located in the center of the building, and although all the soft hats and stiff hats must go into this department four times before they pass to the third and last series of operations, this is accomplished with a minimum of handling. There are six means of entrance or exit to the dry room, allowing practically a continuous movement of material in well defined directions and obviating the possibility of congestion.

The stiffening operations are housed in a separate fireproof enclosure designed especially for this purpose and separated from the rest of the plant in order to confine the area subjected to extraordinary fire risk.

It has been pointed out before that a very considerable amount of space is occupied in connection with the third series of operations for hats in transit, and on this account the total floor area is much greater than is required for the preceding group. Further, there is a great deal of the work that is performed upon benches which requires very good light. Therefore, it was decided to adopt a three-

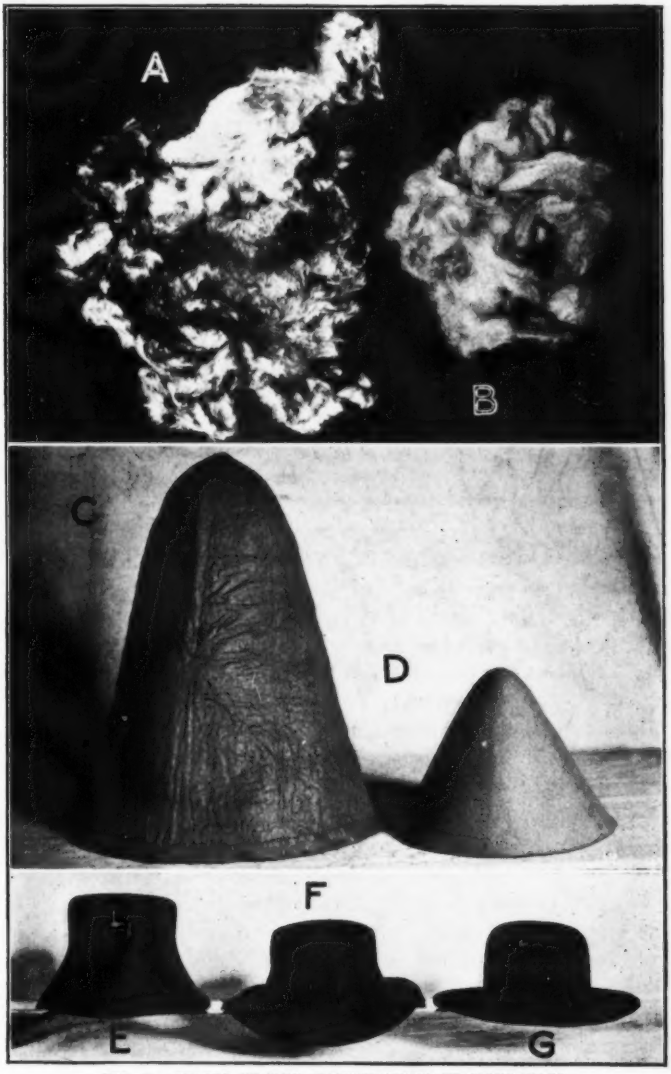
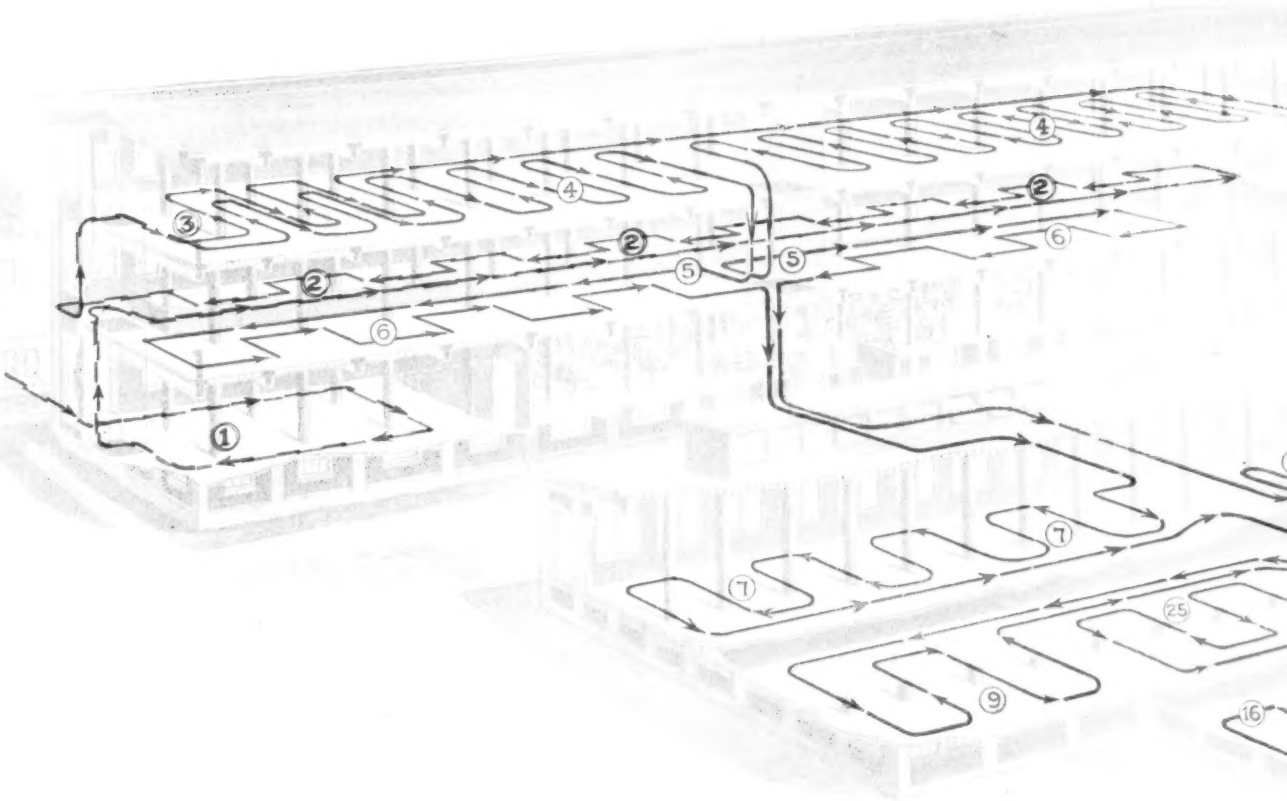


FIG. 2. STAGES IN THE MANUFACTURE OF STIFF HATS.

A, rabbit fur after operation No. 3; B, rabbit fur after blowing, operation No. 4; C, hat body after operation No. 6; D, hat body after operation No. 14; E, hat body after operation No. 23; F, hat body after operation No. 24; G, hat body after operation No. 28.

story building, in order to combine the necessary floor space and bench room along windows and at the same time a desirable routing of the materials. It will be seen that considerably more space is required for finishing the stiff hats than for the soft hats. In order to keep the two kinds of work segregated, the first and second floors are utilized for the former and the third floor for the latter. These finishing operations which are performed in the building to the extreme right of the diagram constitute a complete business in themselves. The rough hats are stored in the first floor directly in the foreground of the perspective, and are shipped from the finished-stores department located at the far end of the same floor and directly adjoining the railroad siding.

While it was not practicable to include in diagram No. 3 a very great amount of detail, yet it should be pointed out that it is through the medium of such a diagram that the over-all dimensions were fixed and building characteristics determined. It will be clear, after it has been studied in detail, that every square foot of floor space is provided for a specific purpose, so that the expenditures for the plant were confined strictly to those needed for the output immediately desired. In order to comply with this requirement, the building provided for the second series of operations was designed to the dimensions indicated rather than a single rectangle in outline. It will also be noted that the second and third floors of the finishing building have been set back so as to provide just the areas needed. However, the plant can be extended readily to provide for growth, without necessitating a rearrangement of departments, except for the equipment used in connection with operations 10, 11, and 12. This would have to be moved into an extension of the building in order to allow for the growth of the dry room. In general the buildings for the first and third series of operations would be extended into the foreground of the illustration, and the building for the second series of operations would be extended at either or both ends, depending upon whether the increase was in stiff or soft hats or both. The only limiting factors in the extension of the plant as a whole are those imposed by the location of the stiffening building and the size of the property. The hat industry is a particularly good one to refer to as a means of illustrating the advantages of the graphical routing diagram, as the process work consists in a large measure of the performance of work upon but a single article, causing its gradual change from the first felt cone to the finished hat. In the majority of industries work must be performed upon a great number of small parts which, of course, makes the routing problem a very much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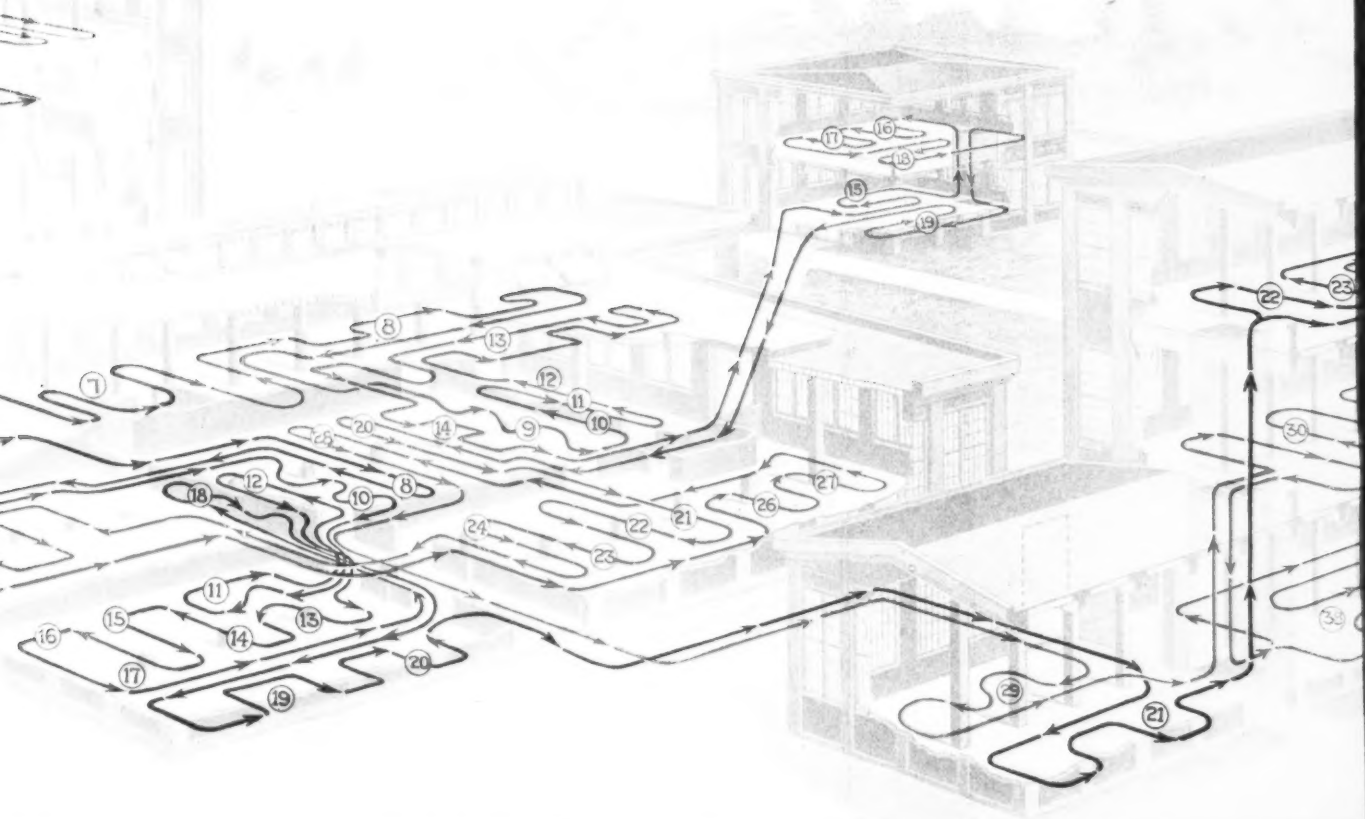
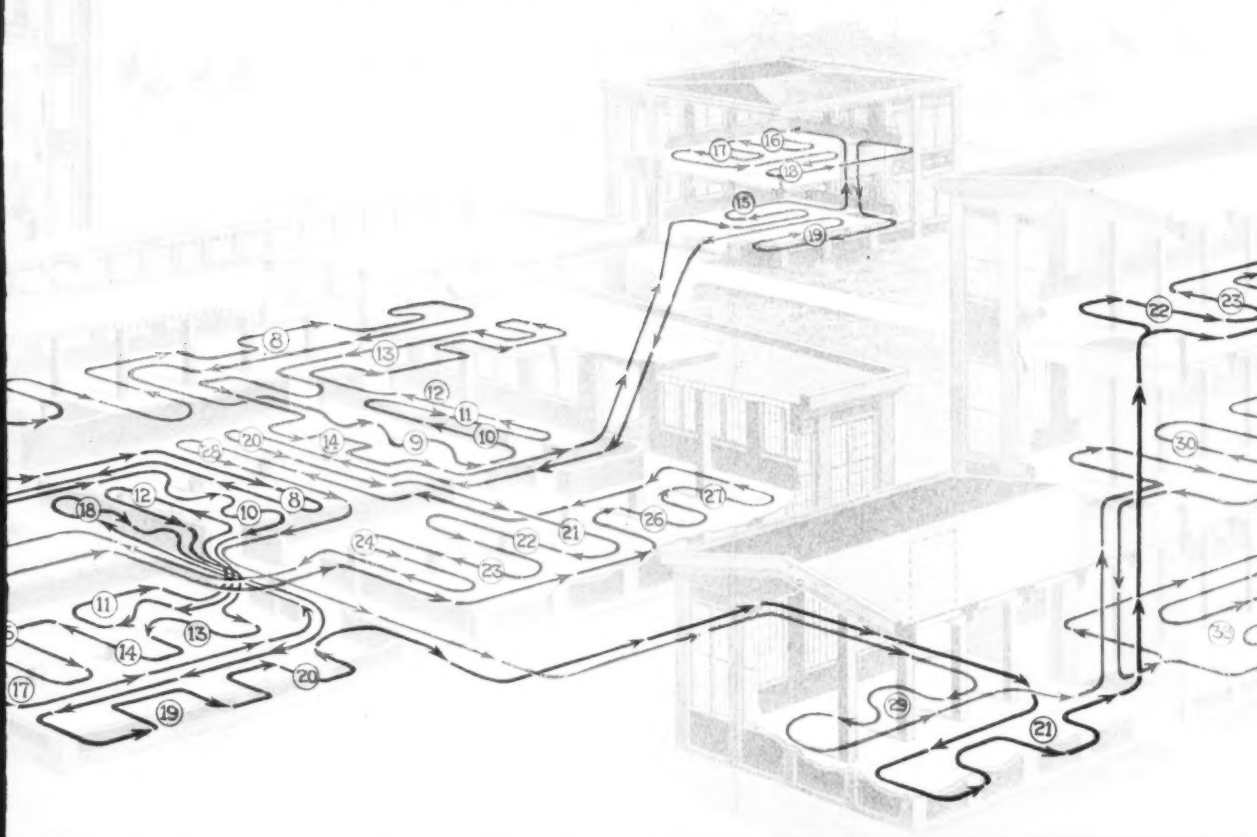
RED Routing Lines and Figures. Sequence of Operations in Manufacture of Stiff Hats: 1, Storage of skins. 2, [illegible] hat body. 7, Sizing. 8, Pinning out. 9, Drying (dry room). 10, Brushing. 11, Shaving. 12, Inspection. 13, Pinning [illegible] 18, Drying in stiffening house. 19, Steaming. 20, Drying (dry room). 21, Clearing. 22, Cold water bath. 23, Ti[illegible] 28, Drying (dry room). 29, Storage of rough hats. 30, Blocking. 31, Pressing. 32, Brim pouncing. 33, Crown pounc[illegible] and binding. 40, Sewing bands and leathers. 41, Labeling. 42, Final cleaning. 43, Packing. 44, Shipping.

BLUE Routing Lines and Figures. Sequence of Operations in Manufacture of Soft Hats: 1, Storage of skins. 2, [illegible] hat body. 7, Sizing and rounding. 8, Drying (dry room). 9, Dyeing. 10, Drying (dry room). 11, Stiffening. 12, [illegible] trifugal drying. 18, Drying (dry room). 19, Brim pouncing. 20, Crown pouncing. 21, Storage (rough hats). 22, [illegible] ing. 28, Binding. 29, Trimming. 30, Flanging. 31, Final finishing. 32, Packing. 33, Shipping.



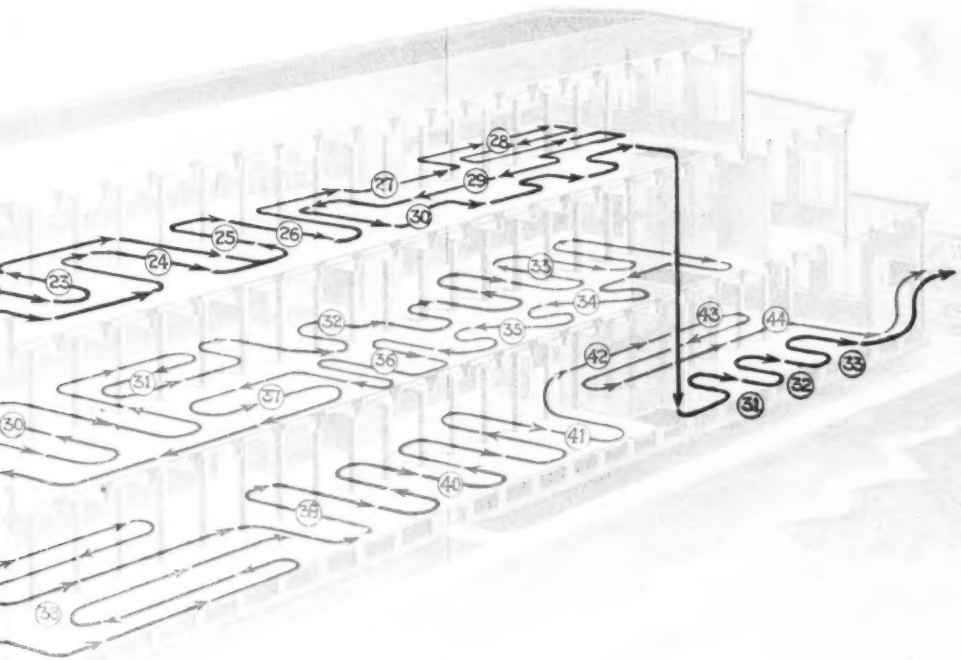
RED Routing Lines and Figures. **Sequence of Operations in Manufacture of Stiff Hats:** 1, Storage of skins. 2, Cu
hat body. 7, Sizing. 8, Pinning out. 9, Drying (dry room). 10, Brushing. 11, Shaving. 12, Inspection. 13, Pinning
18, Drying in stiffening house. 19, Steaming. 20, Drying (dry room). 21, Clearing. 22, Cold water bath. 23, Tip
28, Drying (dry room). 29, Storage of rough hats. 30, Blocking. 31, Pressing. 32, Brim pouncing. 33, Crown pouncin
and binding. 40, Sewing bands and leathers. 41, Labeling. 42, Final cleaning. 43, Packing. 44, Shipping.

BLUE Routing Lines and Figures. **Sequence of Operations in Manufacture of Soft Hats:** 1, Storage of skins. 2, C
hat body. 7, Sizing and rounding. 8, Drying (dry room). 9, Dyeing. 10, Drying (dry room). 11, Stiffening. 12, Dr
trifugal drying. 18, Drying (dry room). 19, Brim pouncing. 20, Crown pouncing. 21, Storage (rough hats). 22, Iro
ing. 28, Binding. 29, Trimming. 30, Flanging. 31, Final finishing. 32, Packing. 33, Shipping.



ins. 2, Cutting fur from skins. 3, Mixing fur. 4, Blowing fur. 5, Weighing fur. 6, Forming and hardening
Pinning out. 14, Drying (dry room). 15, Stiffening rim and tip. 16, Tempering. 17, Recovering alcohol.
23, Tip stretching. 24, Brim stretching. 25, Dyeing. 26, Stretching and blocking. 27, Centrifugal drying.
n pouncing. 34, Rounding. 35, Curling. 36, Shellacking. 37, Matricing. 38, Hand cleaning. 39, Wiring

ins. 2, Cutting fur from skins. 3, Mixing fur. 4, Blowing fur. 5, Weighing fur. 6, Forming and hardening
. 12, Drying (dry room). 13, Steaming. 14, Brim stretching. 15, Tip stretching. 16, Blocking. 17, Cen-
. 22, Ironing crowns. 23 Brim pouncing. 24, Finishing on benches. 25, Rounding. 26, Curling. 27, Flang-



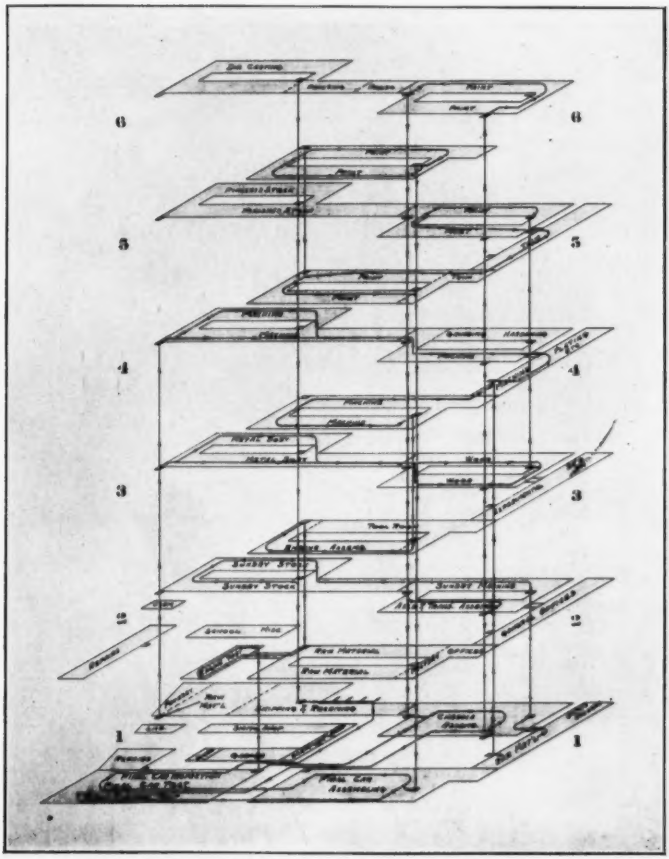


FIG. 4. PERSPECTIVE ROUTING DIAGRAM, IN OUTLINE, SHOWING PATHS FOLLOWED DURING MANUFACTURE OF PRINCIPAL UNITS ENTERING INTO GASOLINE AUTOMOBILES. SEE PAGE 818.

more complex one. Under such circumstances there is almost sure to be a considerable amount of travel in a backward direction, and the arrangement of departments and equipment that is finally adopted will represent, at the best, but a compromise of many conflicting conditions. In contrast with this state of affairs, it will be noted that the routing lines shown in Figure 3 progress uniformly from the point where the work commences to the shipping department, and indicate to all intents and purposes the actual paths over which the specially designed trucks used for transporting the hats are moved.

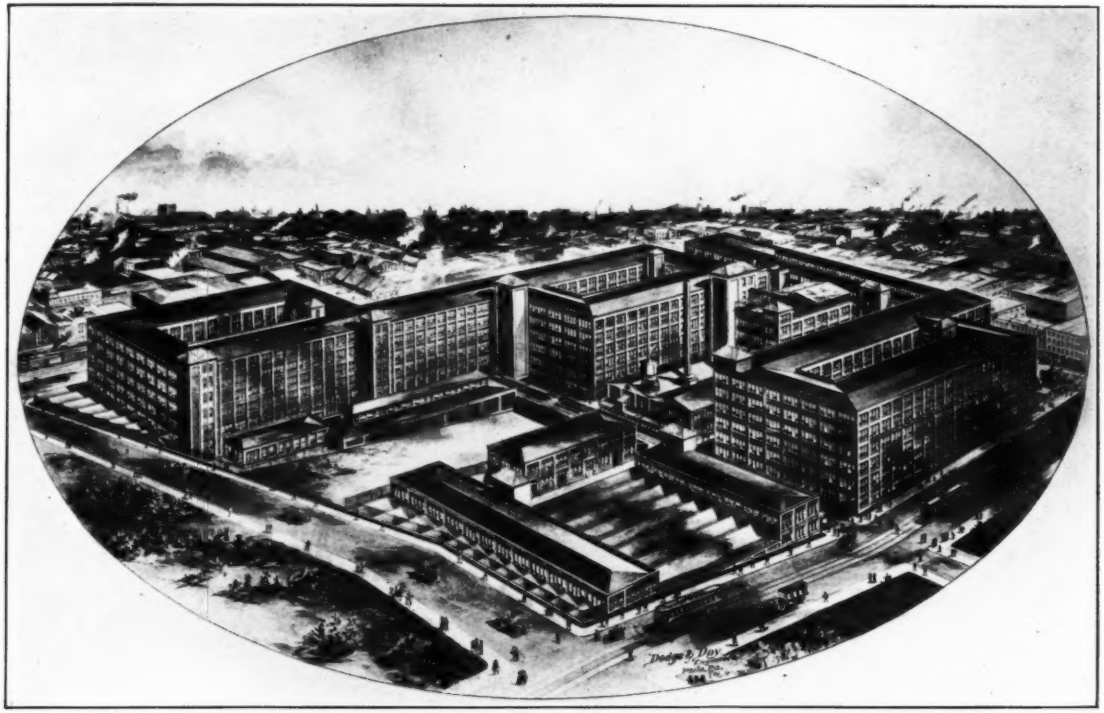


FIG. 5. EXTERIOR VIEW OF AUTOMOBILE PLANT TO WHICH THE ROUTING DIAGRAM (FIG. 4) RELATES.

In actual practice it is not feasible to work up a number of alternate diagrams in as great detail as the one that has just been described, but a very satisfactory result can be secured by laying out the various floors of multiple-story buildings in outline perspective, indicating the routing lines in the manner shown in Figure 4. This diagram, like the one illustrating the progress of the materials through the hat factory, shows the plant as a whole but does not give in detail the actual routing that would take place within individual departments. Nor has any attempt been made to route the individual parts, numbering several thousand, that enter into the construction of a complete gasoline automobile. The diagram is in reality but a "key" indicating the principal paths of travel of materials from the point where they are received until they reach the shipping department in their completely assembled state. The detail routing for such a plant must be shown on large-scale drawings of individual departments. Figure 5 is a perspective view showing the exterior of the plant as a whole.

A diagram illustrating the fullest application of the routing principle is illustrated by Figure 6, which shows the layout of a plant used for the manufacture of wagon and carriage axles. In this instance the location of each piece of equipment is clearly indicated on the blue print and the routing lines show the exact paths followed by materials from the point where they are received until finished and ready for assembling with wheel boxes. This illustration was chosen as it represents a plant complete in every particular.

A consideration of the series of diagrams which accompany this article will serve, I am sure, to emphasize the fundamental importance of the routing problem as bearing upon the laying out of industrial plants. In order to develop the routing scheme properly one must make a thorough study of all the more important factors entering into the business that is to be housed, and on this account the routing diagram forms the logical basis upon which to develop and reconcile all detail considerations, for it is in this particular that they all have a common ground. The problem is in its essence one of determining the inter-relationships which should exist among an aggregation of acts and operations in order to accomplish a given result with maximum economy. Now, in order to determine whether a given series of acts or operations is a desirable one, it is imperative to consider the effects produced by each upon those that follow, for the conditions existing at every stage are the result of all prior acts or operations. Therefore, the primary problem that confronts the engineer engaged upon this work is to forecast accurately results

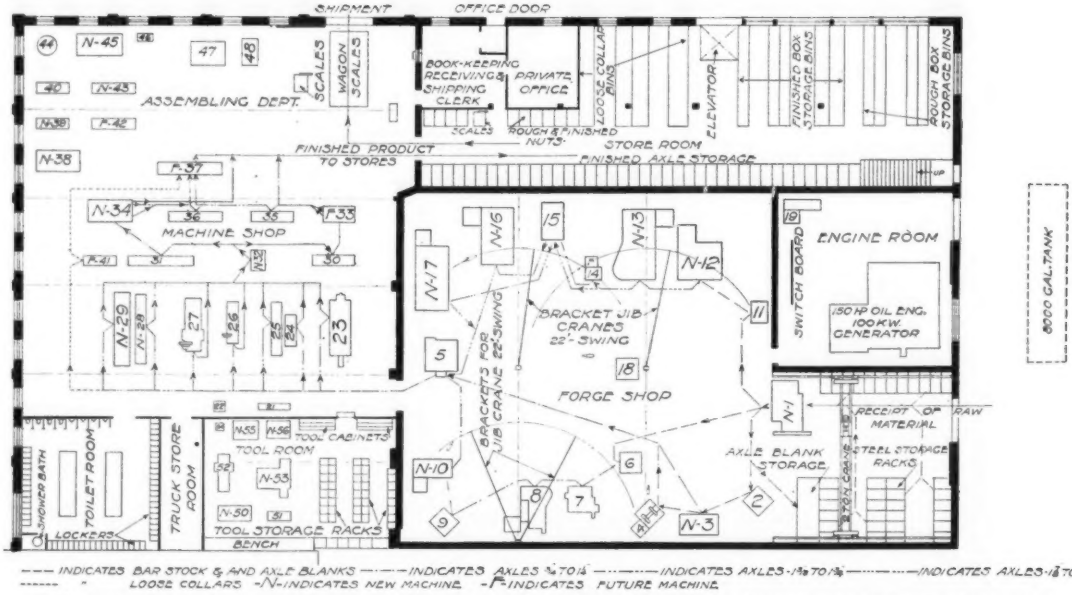
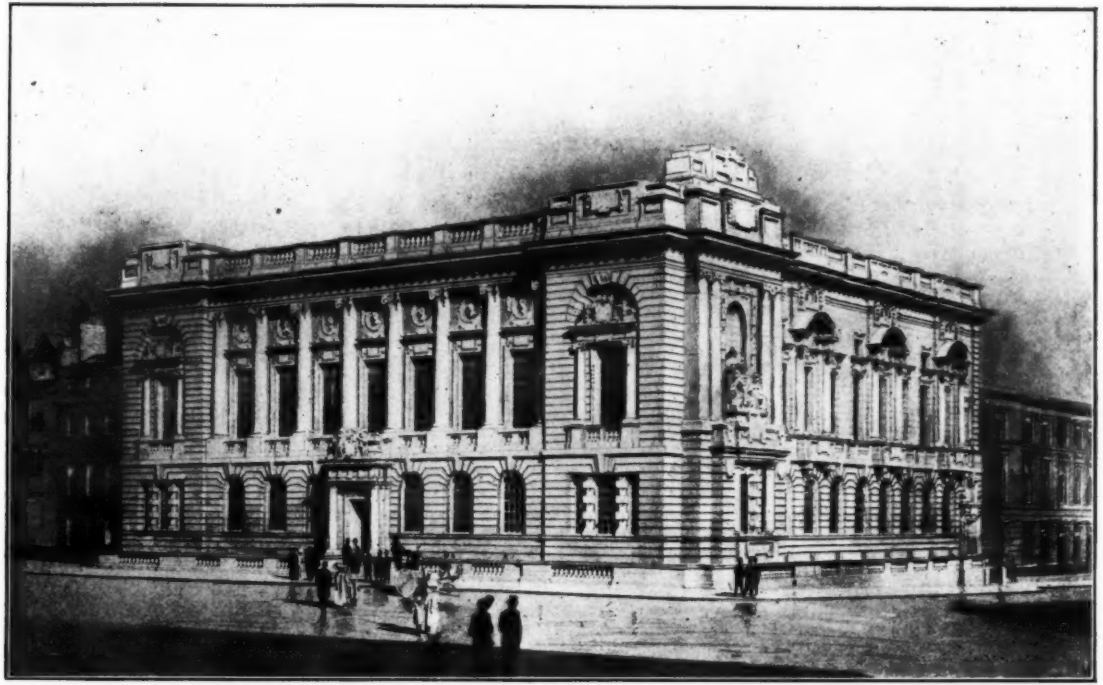


FIG. 6. DETAIL ROUTING DIAGRAM; MACHINE-TOOL EQUIPMENT AND PATHS OF PARTS IN A WAGON- AND CARRIAGE-AXLE PLANT.

1, 4-in. bar shear. 2, oil furnace. 3, forging press. 4, 100-lb. hammer. 5, clipping shear (old 3-in. bar shear). 6, oil furnace. 7, 2½-in. Ajax taper rolls. 8, 2½-in. upsetting machine. 9, oil furnace. 10, 400-lb. Yeakley pneumatic hammer. 11, oil furnace. 12, 4-in. taper rolls. 13, 4-in. upsetting machine. 14, punch press. 15, 24-in. by 72-in. oil furnace. 16, 600-lb. Yeakley pneumatic hammer. 17, No. 6 Williams White bulldozer. 18, oil furnace. 19, Queen City pressure blower and oil pump. 21, portable hydraulic axle-straightener (50 ton). 22, 18-in. by 18-in. oil furnace. 23, 1¼-in. triple axle ram. 24, 16-in. by 6-ft. Porter lathe. 25, 20-in. by 10-ft. Garvin lathe. 26, 1¾-in. single axle ram. 27, 3-in. single axle ram. 28, double-head axle lathe (Bridgeford). 29, 42-in. by 14-ft. engine lathe (30-in. lathe raised). 30, 20-in. by 8-ft. engine lathe (for filing work). 31, 22-in. by 12-ft. engine lathe (for filing work). 32, Whitney milling machine (for cutting oil grooves). 33, 1½-in. single-head Acme bolt-cutter. 34, 2½-in. ditto. 35, 20-in. by 8-ft. Johnson lathe. 36, 32-in. by 14-ft. Bishop lathe. 37, hydraulic press for forcing on loose collars. 38, double-head Acme 2-in. nut tapper. 39, nut-facing machine. 40, Monitor turret lathe for recessing nuts. 41, chucking lathe for loose collars. 42, 20-in. engine lathe (for finishing boxes). 43, ditto. 44, 1¼-in. quadruple box reamer. 45, 4-spindle drill (for reaming boxes over 1¼ in.). 46, 2-wheel grinder. 47, 36-in. by 18-in. case-hardening furnace. 48, tempering trough. 50, 14-in. by 6-ft. tool-room lathe. 51, 22-in. Sargeant drill press. 52, 20-in. by 20-in. by 5-ft. New Haven planer. 53, No. 2 universal milling machine. 54, 12-in. by 12-in. tool-tempering oil furnace. 55, Sellers No. 2 universal tool grinder. 56, surface grinder.

that will follow if certain procedures are carried out, and this can be done only be considering in regular sequence causes and effects, commencing with the initial factor. Consequently, the work must of necessity be handled in an orderly and consecutive manner, and if the habit of mentally grouping facts graphically is cultivated to the point where such images can be promptly summoned into existence, resulting conditions are much more readily anticipated.

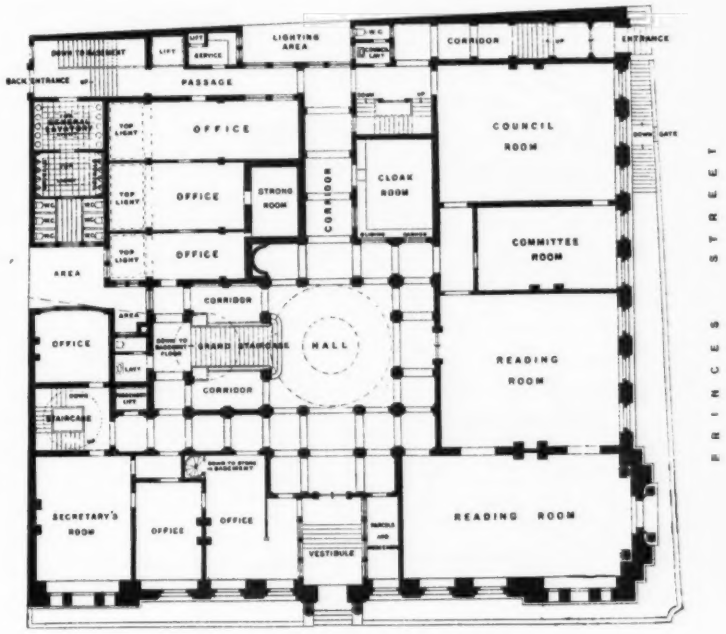
One of the principal factors entering into modern methods of industrial administration is that of scheduling the work from a central planning office in a manner that provides for the completion of each unit of work in a certain time. It is found that if such a system is properly established great economies result as compared with any results that are possible if no regular schedule is enforced. The importance of the schedule is best illustrated in connection with the operation of large railroad systems. They depend for their very existence upon the exact adherence to a train schedule which defines the arrival and departure of every train at every important point upon the system. Such a schedule, however, can be carried out only after the tracks, terminals, yards, and stations have been laid out strictly in accordance with the requirements of the schedule itself. In other words, a routing diagram must be made of the entire system, based upon the series of schedules that it is proposed to establish. If a certain degree of flexibility can be provided for, this of course must be taken advantage of; but in any case there will be certain well defined conditions such, for example, as the location of sidings, distributing yards, etc., if it is a single-track line. This is a well recognized principle in railroading and is fundamental to the operation of practically all systems both large and small. The only reason that it has not been recognized as of almost equal importance in industrial work, is because an industrial plant *can* operate without any clearly defined schedule, and therefore without any carefully prearranged layout or routing plan. It is not a matter of the physical safety of those who own a plant or are employed as operators, although it may well be one of life or death insofar as the well-being of the business as a whole is concerned. Industrial managers now realize, as they never have before, that the scheduling of their work is one of the prime factors of economic production, and that operating expenses can be minimized only when the plant has been physically arranged in accordance with the requirements of the most efficient schedule.



THE NEW BUILDING OF THE INSTITUTION OF CIVIL ENGINEERS. VIEW FROM ST. JAMES' PARK.

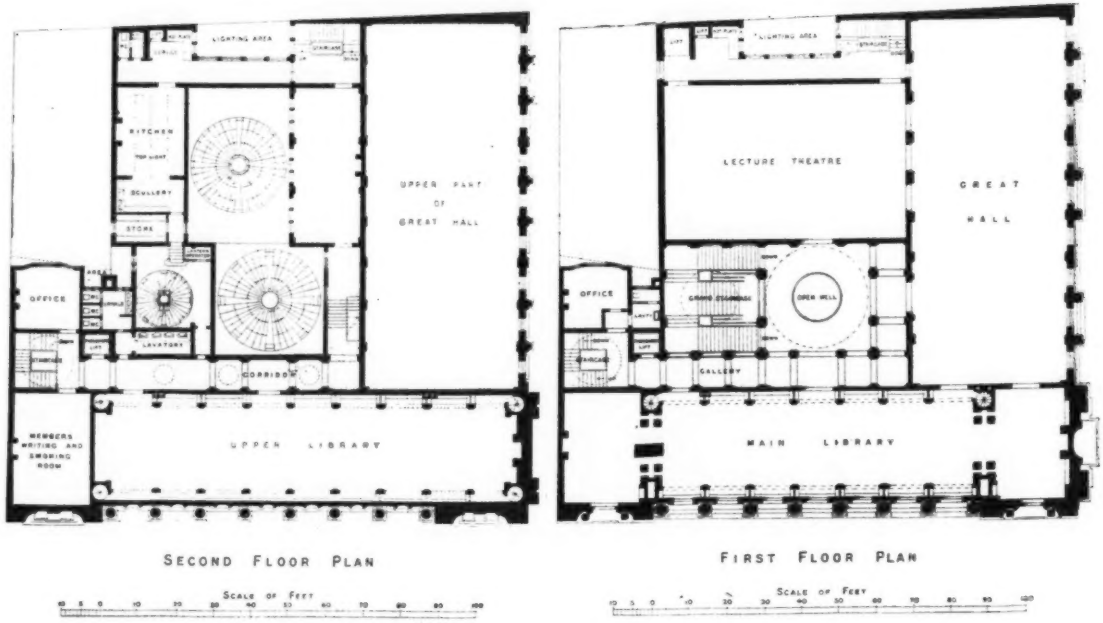
THE NEW BUILDING OF THE INSTITUTION OF CIVIL ENGINEERS.

THE perspective elevation opposite and the floor plans below and on page 824 give an idea of the new building of the Institution of Civil Engineers, designed by Mr. James Miller, F. R. T. B. A., to replace the premises at 25 Great George St., now required for the extension of the Government offices.



GROUND FLOOR PLAN

SCALE OF FEET



UPPER FLOOR PLANS OF THE NEW BUILDING OF THE INSTITUTION OF CIVIL ENGINEERS.

A GENERAL REVIEW OF HYDROELECTRIC-ENGINEERING PRACTICE.

By Frank Koester.

V. THE FINANCIAL ASPECTS OF HYDROELECTRIC UNDERTAKINGS.

Mr. Koester here concludes his series begun in April last. Having had early and broad European training in connection with various kinds of power developments for Europe and Asia, and having been associated with many such engineering enterprises in the United States, Mexico, and South America during the past ten years, he is well qualified to give sound opinions as to the fundamental requirements and the state of the art, and their application in the important field of hydroelectric development and the conservation of natural resources.—THE EDITORS.

HAVING covered in preceding papers the design, construction, and operation of complete hydroelectric plants, from the harnessing of water to the delivery of electric current to the consumer, it remains to close the subject with an addendum on the financial aspect of water power developments and their electric utilization.

Progress in the development of engineering enterprises of all kinds is stimulated by the interchange of ideas and the knowledge of what is being done the world over. As it is recognized among the leading engineers that Europe abounds in hydroelectric developments it is doubly important that the engineer shall be familiar with foreign practice.

In Europe the limited coal supply early induced the utilization of water resources, and the various European governments encouraged the movement by granting favorable franchises.

As emphasized in the first paper of this series, America is a land of unlimited possibilities, is rich in natural resources of all kinds, including water-powers, and as our engineers always strive to produce engineering work at a record-breaking rate, the United States naturally leads all countries in water-power projects on a large scale. Great financial resources being at hand, it is possible to secure great results in a limited space of time, and this is done in order to place the proposition on a paying basis as quickly as possible, frequently regardless of real economy. This sacrifice is due to the fact that many engineers do not take the time to ponder over the many small details upon

GENERAL VIEW OF NIAGARA FALLS, SHOWING THE POWER DEVELOPMENTS ON THE CANADIAN SIDE.
1, Intake, Ontario Power Co. 2, Electric Development Co. 3, Canadian Niagara Power Co. 4, Power House, Ontario Power Co. 5, Distributing Station, Ontario Power Co.

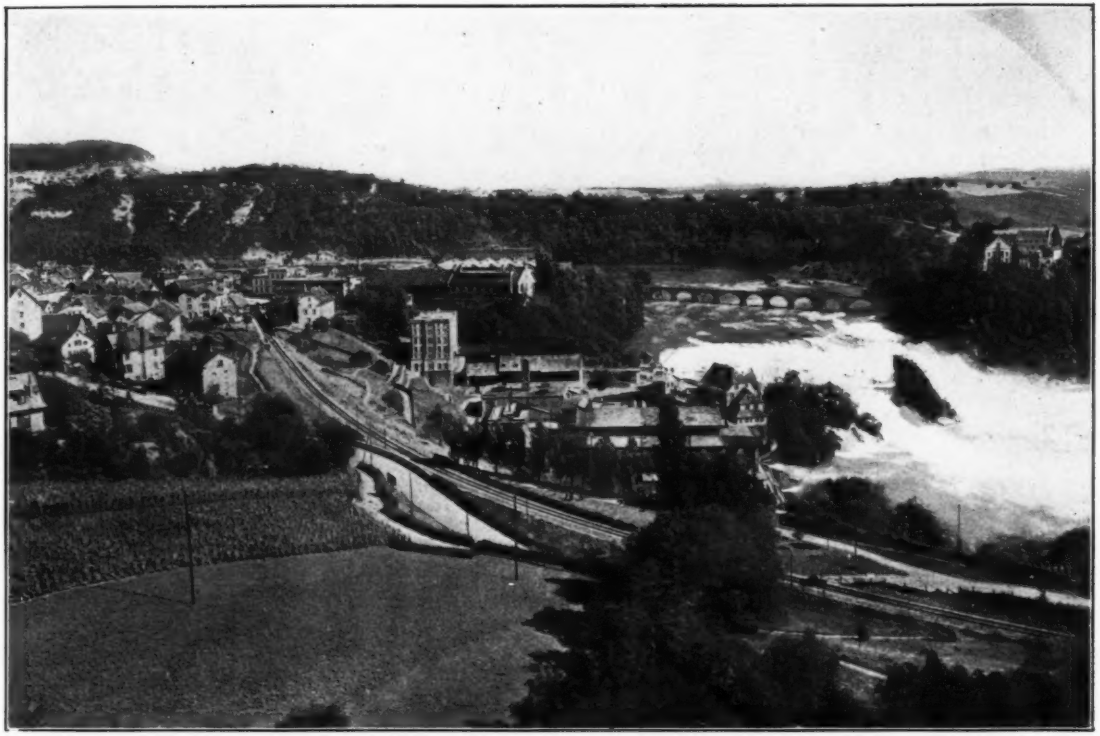
which the final success of the proposition from a financial standpoint usually depends, and have not that universal knowledge to use as a starting point and to build upon in the planning of great projects, so that future overhauling and remodeling may not be necessary.

In connection with water-power developments much preliminary study is necessary as to the drainage area, the possibility of collateral enterprises and projects (such as irrigation, or waterways for navigation, river regulations and city water supply), the present and possible future market for power, and further the possible secondary power developments. With the aid of expert engineers these matters can be properly and definitely determined. Capitalists or corporations having need of such services should first make thorough investigation as to the responsibility and actual reputation of the consulting and contracting engineers. It happens only too often that capitalists employing engineers for carrying out a project do not again engage the same men for their next proposition, the reason therefor probably being a lack of thorough investigation before giving them the first commission.

As the financial success of any project depends largely upon the ability of the engineer and his staff, it is equally important to extend the investigation in this direction. This applies particularly to those engineering firms which are obliged, because of lack of continuity of their commissions, or for other reasons, to make frequent changes in their staff. Many instances have occurred where, during the progress of the work, the engineer in charge or his principal assistants, for some reason or other, have left the employ of the concern. The effect of such interruption in the progress of the work may readily be appreciated, and the trouble is usually due to a lack of management or generalship on the part of the engineering firm. Often, for this reason, the first cost is excessively high, the efficiency and economy in operation do not meet the expectations, and the enterprise is a failure financially. This condition cannot be easily remedied. It is sometimes effected, however, and then at great cost, after the plant has been in operation for a year or more. This of course may be defined as experimenting pure and simple, at the expense of the capitalist, and this can be avoided only by employing consulting engineers in the first instance who have broad knowledge and experience.

Combination Developments.

In many instances correct advance calculations might show that a proposition would be more financially desirable, if a combination system formed the basis of the scheme. For instance, a hydroelectric



AN INDUSTRIAL TOWN ON THE FALLS OF THE RHINE. OWES ITS EXISTENCE AND ACTIVITY TO HYDROELECTRIC DEVELOPMENTS, WITHOUT DESTRUCTION OF NATURAL BEAUTY.

development might be incorporated with a proposition for the water-supply of a city, the power plant being so situated that the discharge water from the turbines has sufficient head to supply, by the gravity system, a town or city with its water requirements. In some cases this might mean that some of the available head may be lost to the turbines. In other cases, where there is an abundance of water, that for the city supply may by-pass the power house, or the discharged water may be pumped for city purposes.

An ideal system which may be developed in the interest of smaller cities, is to utilize the water power for supplying electric light and power as well as for the regular supply of water to the city.

Many of our arid sections, particularly in the western States, require systems of irrigation and such projects in connection with the prior utilization of the flow of water of a stream for power purposes would be often desirable and would form the basis of an economical proposition considered from a financial point of view. Here again the power house may be so situated that sufficient head is left to allow the discharge water to be distributed for irrigation over the surrounding section; or pumping stations using the electric current for driving the pumps may be located at suitable points. This scheme of pumping will make the proposition an economical one, as the pumping will be done at such times as the load at the power house is lightest, namely, in the summer time when a minimum amount of current is necessary for lighting purposes.

In order to protect the surrounding country against floods, river regulations often provide for changing the course of a stream and often also for raising the bed of the stream, and in both instances advantage may be taken, where possible, of the additional head which may be secured at a certain point, by utilizing such head for generating current.

In a farming community the county might utilize a hydroelectric development for supplying, from a central station, the power needed for farming on a modern and scientific basis, or a number of farmers may be interested in the promotion of such enterprises, utilizing the power in common for the purpose of carrying on their farming operations, including the lighting of farm buildings and dwellings. Electric power may be readily applied with the use of motors to all agricultural machinery such as plows, reapers, mowing machines, pumps, threshing machines, fodder cutters, feed grinders, washing machinery, creamery appliances, refrigerating installations, etc. By the use of electric light on the farms greater efficiency and cleanliness

LAKE POSCHIAVO. A NATURAL RESERVOIR WHICH IS SIPHONED AND DEVELOPS ABOUT 75,000 HORSE POWER, AT 1,300 FEET HEAD, THROUGHOUT THE YEAR.

is secured all around, fire risk is diminished and insurance rates are reduced, and the working day is not shortened in the winter season.

The great cry has for some time been raised that a livelihood cannot at present be made on the farm. The great problem is to produce more per acre and to make the laborer's position on the farm so attractive that he will be willing to remain there. It is my opinion that a good reason for the retrogression of the farming industry is that all modern engineering ability has almost exclusively been directed to the advancement of industrial enterprises, and has almost entirely neglected farming and agricultural work. Financiers and promoters will no doubt find this a great field, particularly as with the use of electric power many by-products of value may be produced commercially on farms, such as alcohol, starch, etc., from the surplus products.

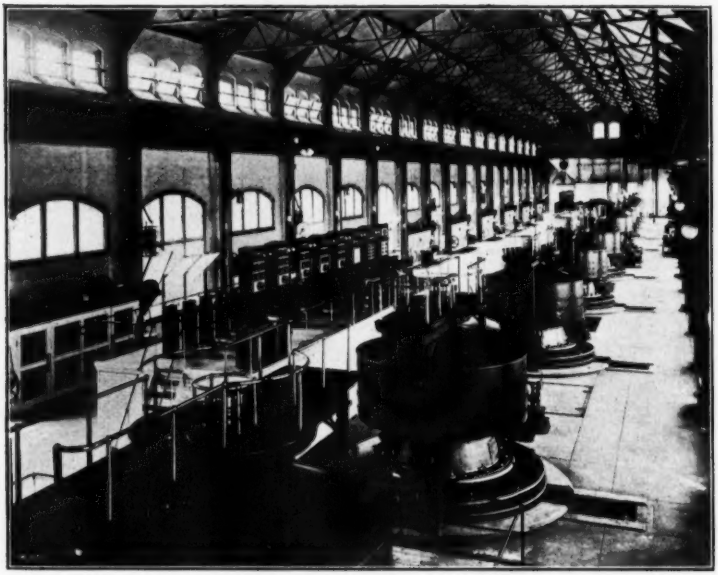
A further great and promising field for the utilization of electric current is opened by the use of electro-chemical processes which will make profitable the development of many water-powers that otherwise would not be so, and water-powers which now have no available market will be made valuable. Processes not requiring a continuous supply of current will permit the utilization of power during otherwise light load periods. This would include the manufacture of air nitrate for fertilizing purposes, which field is beginning to open up.

Water Storage.

There are many large hydroelectric propositions which would not warrant the expenditure, at the start, of that amount of capital necessary to build a dam of such size and character as would meet the ultimate requirements, or to develop fully the water-power in question, and the demand for current may not require it at the start. Proper investigation will determine as to how such power may be developed in stages without the investment of a very much larger sum than would be necessary to complete the final dam at the start.

This might be accomplished by building the dam to a certain height, making all provisions for increasing the height to take care of the volume of water to be ultimately impounded. Another method consists in impounding the water in stages by building smaller dams at different elevations, providing the profile of the river will permit of this. In the latter case the possibility might arise that a number of power houses might have to be provided, depending upon the number of stages of development; or this might be accomplished with these several dams by employing long pressure pipes leading to a

common central power plant. Investigation must show which plan should be adopted from the financial point of view, bearing in mind that in some instances several smaller dams might cost considerable more than one large one. The skill of the engineer will determine which plan is the most economical.



INTERIOR OF THE FIRST GREAT HYDROELECTRIC STATION AT NIAGARA FALLS.
An excellent example of commercial success.

A method recently introduced on the Continent of Europe, where coal as well as water-power is scarce, and where the current can be disposed of at a remunerative rate, consists in using the discharge water over again by pumping it back, during periods of light load, to the reservoir by means of a centrifugal pump mounted upon the same shaft with the generator or driven by a separate motor. This latter arrangement has a certain advantage, in that the main turbo-generator set is cut out entirely when the pumping is done, while in the former case, when the water to the turbine is shut off, the generator will automatically start to work as a synchronous motor to operate the pump. Some years ago when the natural water-power resources were not so restricted, such a proposition would not have been considered economical as the re-imponding would be done at a considerable loss of energy, it being borne in mind for one thing that the efficiency of a centrifugal pump hardly ever exceeds 75 per cent. Add to this

BRUSIO. A MODERN SWISS HYDROELECTRIC PLANT, TRANSMITTING POWER FOR MANUFACTURING PURPOSES TO ITALY.

the loss in the generators or motors and the friction in the pressure pipes, and last and most important the power required to lift the water back to the reservoirs, and it will be seen that to determine this proposition to be a paying one, very fine preliminary calculations are necessary.

Cost of Hydroelectric Developments.

The cost of hydroelectric developments depends upon many conditions, such as water right, real estate, right of way, the cost of the

UPPER FALL OF THE YOSEMITE, 1,600 FEET HIGH.

development, and the distribution system. Further, the depreciation, repairs, taxes, insurance, interest on the investment, operating expenses, etc., enter into the account.

The cost of the enterprise depends very much on the character and the conditions under which the development is carried out, and the cost per unit capacity depends upon the total capacity of the plant. It occurs quite frequently that the unit cost in large propositions is greater than in small ones, although it would appear that it should be smaller. This is due to the fact that in many large propositions a heavy expense is involved in the harnessing of great volumes of water.

Table I, accompanying, gives figures on the estimated costs of various developments tabulated by the Ontario Hydroelectric Power Commission, while Table II gives the estimated cost of a hydroelectric plant at Niagara Falls, as given in the report of abovenamed Commission.

TABLE I.—ESTIMATE OF COST OF VARIOUS DEVELOPMENTS.

Location of Development	Nat'ral Head	Available Head	Power Developed h. p.	Estimated Capital Cost	Cost per h. p.
Healey's Falls, Lower Trent River...	—	60	8,000	$675,000	$84.38
Middle Falls, Lower Trent River.....	—	30	5,200	475,000	91.37
Rauney's Fall	—	35	6,000	425,000	69.67
Rapids above Glen Miller.....	—	18	3,200	350,000	109.38
Rapids above Trenton.....	—	18	3,200	370,000	115.63
Maitland River[1]	—	80	1,600	325,000	203.12
Sangeen River	—	40	1,333	250,000	187.53
Beaver River (Eugenia Falls).....	—	420	2,267	291,000	128.28
Severn River (Big Chute)[2]	—	52	4,000	350,000	87.50
South River	—	85	750	150,000	153.33
St. Lawrence River, Iroquois, Ont....	—	12	1,200	179,000	149.16
Mississippi River, High Falls, "A"[3] ..	—	78	2,400	195,000	81.25
Mississippi River, High Falls, "B"...	—	78	1,100	123,000	181.82
Montreal River, Fountain Falls, Ont..	—	27	2,400	214,000	89.16
Dog Lake, Kaministiquia River[4] 347	310	13,676	832,000	61.00
	347	310	6,840	619,700	91.00
Cameron Rapids	39	—	16,350	815,000	50.00
	39	—	8,250	600,000	73.00
Slate Falls	31	40	3,686	357,600	97.00
	31	40	1,843	260,000	141.00

(1) Dam rather expensive. (2) Head works and canal less expensive than ordinary.
(3) With storage development. (4) Including 3,500 feet of headwater tunnel.

TABLE II.—ESTIMATE OF COST OF HYDROELECTRIC PLANTS AT NIAGARA FALLS

	24-Hour Power Capacity		
	50,000 h. p. Development.	75,000 h. p. Development.	100,000 h. p. Development.
Tunnel Tail Races $1,250,000	$1,250,000	$1,250,000
Headworks and Canal	450,000	450,000	450,000
Wheel Pit	500,000	700,000	700,000
Power House	300,000	450,000	600,000
Hydraulic Equipment	1,080,000	144,000	1,980,000
Electrical Equipment	760,000	910,000	1,400,000
Transformer Station and Equipment...	350,000	525,000	700,000
Office Building and Machine Shop.....	100,000	100,000	100,000
Miscellaneous	75,000	75,000	75,000
	$4,865,000	$5,900,000	$7,255,000
Engineering and Contingencies.....	485,000	590,000	725,000
	$5,350,000	$6,490,000	$7,980,000
Interest, 2 years @ 4%.....	436,560	529,584	651,168
Total Capital Cost.....$5,786,560	$7,019,584	$8,631,168
Per Horse Power.....	$114	$94	$86

It will be noticed by reference to Table I that the cost of hydro-electric plants per horse-power, varies greatly (from $61.00 to $203.00) and may vary even more. Correct estimates can be arrived at only by thorough investigation of all the factors, considering with especial care the important element of depreciation.

The Cost of Power.

In estimating the cost of power (that is, the generation and distribution, which of course depends very much upon the load factor) administration and operating expense, maintenance, depreciation, interest, insurance, etc., must also be well considered. The following table clearly illustrates the cost of power at the development of the Chicago Sanitary District System.

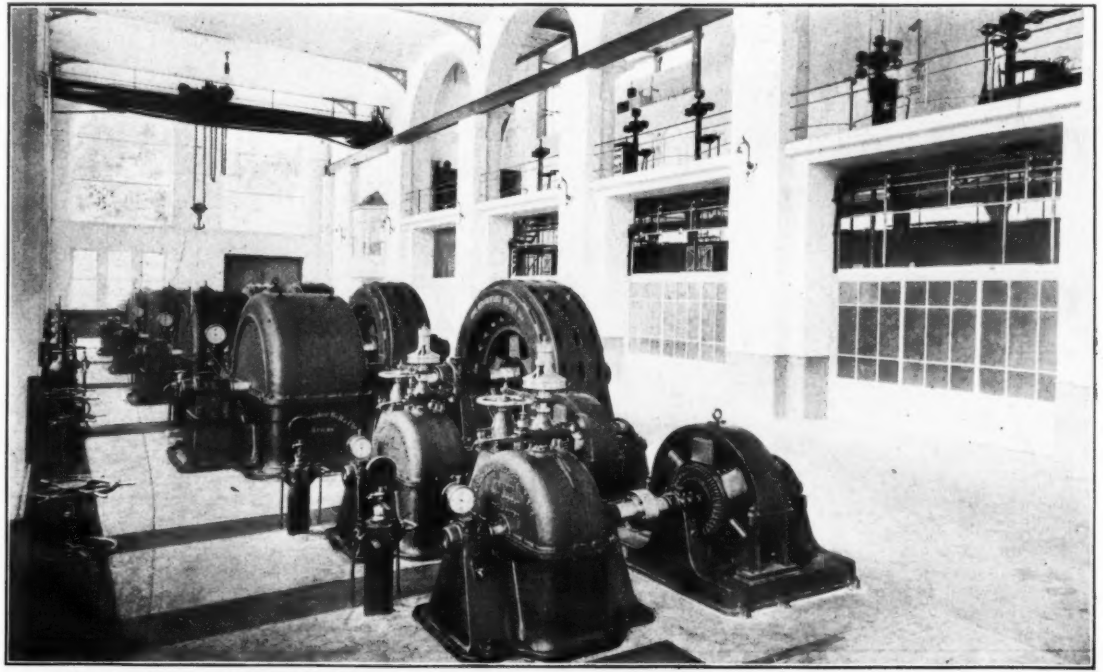
Table III.—Cost of Power, Chicago Sanitary District System.

Total Cost of Development and Transmission		$3,500,000
Estimate of Cost.		
Interest on investment at 4 per cent	$140,000.00	
Taxes on Real Estate, Buildings, etc	7,200.00	
Depreciation of Buildings at 1 per cent	3,650.00	
Depreciation on Water Wheels at 2 per cent	2,027.32	
Depreciation on Generators at 2 per cent	1,824,60	
Depreciation on Pole Lines at 3 per cent	2,020.50	
Depreciation on other Electrical Appliances at 3 per cent	3,995.52	
Total fixed charge		$161,137.94
Operating Expenses.		
Power and Substation Labor	$63,240.00	
Repairs to Machinery and Buildings	3,700.00	
Incidental Expenses	1,200.00	
Operating Lawrence Avenue Pumping Station	43,960.00	
Operating 39th Avenue Pumping Station	120,380.00	
Interest on Investment 39th Street Pumping Station	15,599.76	
Total Operating Expense		248,079.76
Total Cost to Sanitary District		$409,217.70
Capacity, 15,500 h. p., Cost per h. p. per annum		$26.40

A most important item in determining the cost of power is the cost of distribution. This is particularly true in long-distance transmission systems where the skill of the engineer is of vital importance in selecting the proper route and the kind of systems to be employed.

Whether a long-distance power transmission project will pay will depend upon the cost of generating the power, the cost of trans-

AN UNDEVELOPED MEXICAN WATER POWER—SALTO GRANDE, 740 FEET.
The hydroelectric plant from which the power already developed here is obtained operates under 1,400 ft. head, generating 50,000 horse power for 170-mile transmission.



A MODERN CONTINENTAL HYDROELECTRIC STATION SUPPLYING A CITY OF 150,000 WITH LIGHT AND RAILWAY POWER.

mission, the transmission loss, etc., and the value of energy at the point of distribution, i. e., the cost at which energy might be generated at this point by some other system as, for instance, by a steam power plant. The difference between the cost of power at the generating end and its value at the point of distribution represents the maximum cost of transmission allowable.

The cost of steam power plants varies from about $75 to about $125 per kilowatt capacity, or from $50 to $83 per horse power, and the following table, IV, taken from the author's work, "Steam Electric Power Plants," represents fair average figures per kilowatt capacity, aggregating $104.50, or $70 per horse power. Steam plants can be and have been installed, under favorable conditions, as low as $50 per horse power, and have cost as high as $100 per horse power. This of course represents only the first cost of installation and does not cover the item of real estate and right of way.

TABLE IV.—COST OF STEAM-ELECTRIC POWER PLANTS.

Excavation and foundations	$5.00
Buildings	20.00
Condenser water tunnels	3.75
Flues and smoke stacks	3.50
Boilers and stokers	12.00
Superheaters	2.25
Economizers	2.25
Coal and ash-handling systems	3.00
Blowers and conduits	1.50
Pumps and tanks	1.25
Piping systems	5.00
Engines	22.00
Condensers	5.00
Exciters	1.00
Generators	12.00
Crane	.50
Switchboard equipment	3.50
Miscellaneous	2.00
Total per kilowatt capacity	$104.50

In figuring the cost of power in such plants still further items must be taken into consideration such as coal, boiler-feed water, (which in many instances must be drawn from city mains,) the greater cost of lubrication and also of repairs, larger pay-roll, increased insurance and taxes, and larger item of depreciation, as compared with hydroelectric plants.

MARKETING ELECTRIC CURRENT.

The finding of a proper market for light and power is of as great importance as the development of the plant, and this feature must therefore receive prompt consideration so that a proper load factor

exists at all times. As the bulk of the demand for current is for stated hours of the day, a market must be at hand and secured for the furnishing of current during the periods of the day when the load is light. This influences the fixing of rates which must be charged for current. The greater the market, and therefore the greater the product, the lower the rate which may be charged for current and still insure sufficient net income to meet interest charges, amortization and dividends.

In the fixing of rates for cities, where public franchises have been granted to the company, two principles are involved, viz: First, the company has been granted certain privileges by the public for the purpose of enabling it readily to render some kind of service to the people, and it is to be expected that the company furnish such service as fits the needs of the people and at prices which are reasonable taking all conditions into consideration; second, the company must not be harassed in any manner but should be offered every reasonable opportunity for conducting its business economically so far as giving the service for which the company was organized, and this is being more and more appreciated by the public bodies which control such affairs. The company must be allowed to make a clear profit for its service such as will attract the best talent for its management and allow it to maintain a stable credit with the investing public.

A semi-public corporation cannot do business on the usual margin of general manufacturing profit. Such corporation, instead of making a gross annual income equal to or exceeding the capital investment, ordinarily must expend a sum in establishing its plant and business which is several times the possible annual gross income.

As already indicated throughout these papers, it may be said in conclusion that the fundamental requirements for any water-power development are an efficient source of water supply, a market for electrical current, and the necessary capital; and, in all cases, to determine as to whether the proposition will be financially successful, a thorough preliminary investigation by an engineer of broad experience with a full knowledge of what has already been done in this field is necessary, as promotors, financiers and investors must depend largely upon his investigations and reports. Furthermore, the success of the enterprise will depend not only on the scheme selected, but also upon the ability and experience of the engineer in carrying out the design and construction of the complete hydroelectric development, including all collateral enterprises.

THE TWELVE PRINCIPLES OF EFFICIENCY.

By Harrington Emerson.

IV. THE SECOND PRINCIPLE: COMMON SENSE.

Mr. Emerson's current series began in our June issue. The introductory article was a brilliant demonstration, from historic examples, of the power of certain principles of efficiency. His second paper showed the unsuitability of the ordinary organization for the introduction of these efficiency principles, and indicated the nature of the changes necessary to permit their application. In our August number he reached the "Twelve Principles" themselves, and took up the first—"Clearly Defined Ideals." The present chapter is a striking statement of far-sighted philosophy, practical in the highest sense in its application to the individual, the corporation, the nation. It is a fine example of the best that engineering literature affords.—THE EDITORS.

DARWIN points out that the maternal instinct makes a mother exaggerate the importance of her offspring, thus adding to its chances of survival. Each of us is quite sure he possesses all the common sense needed, and this is also an important instinct, since without it we would lack self-confidence, initiative, we would be deficient in the ability to do, to accomplish. Before the human being runs, he walks, before he walks he creeps, before he creeps he kicks, and the sprawls of the infant give us promise of the man. Let us therefore concede to each mother that her baby is the most valuable ever born, let us praise the excessive and ill-directed activity of the growing boy. Let us also believe that no one is deficient either in quantity or quality of a form of common sense essential in past decades, but now doubly dangerous, since it not only stimulates activities that are becoming in the highest degree deleterious, but it prevents us from preparing for the dawning era in which brains and hand-skill will take up the work begun with boldness and lusty kicks in our exuberant youth.

It is because I have an abiding faith in the destiny both of my country and its inhabitants that I urge the application to its affairs of efficiency principles. That its people has in the past abundantly made use of a high order of *near* common sense justifies the belief that in the future it will surpass other nations in the use of supernal common sense. Let us therefore grasp the difference between the two, and, having grasped it, let us wake up to some of the principal present stumbling blocks in our national, corporate and individual paths.

The surf rider in Honolulu, who, standing on a board, comes in on a curling breaker, is daring, skilled, and intensely alive to the swirls at his feet. He is a good navigator of his kind; but there are men who guide great ships by noting the revolutions of the log, by marking the tick of the chronometer, correcting both by the movements of the planets and the stars. It is by these men, not by the surf riders, that the great business of the world is carried on, but the youthful surf riders of today are to become the guiding captains in the next decade. The common sense of the American is the alert common sense of the surf rider. It is not yet, either nationally, corporately, or individually the common sense of the far-knowing captain on the bridge, and what we need is not more common sense or more alertness, but a diametrical change in our point of view. The boy must forget his surf skill for a while and go to the mountain top and learn to know the stars so that he will hold them as friends whatever sea or desert he navigates or traverses.

A single red copper cent seemed of more worth to the small and terrified soul of a New England statesman than all our splendid country west of the Rocky Mountains, and because he had near common sense, he was willing to sacrifice anything to New England fishing interests; because he was destitute of supernal common sense, he lost to us the empire lying west of the Rockies north of 49 degrees up to 54 degrees 40 minutes, and, no thanks to him, we did not also lose Oregon and Washington.*

Happily there were others, earlier and later, Spanish captains, French gentlemen and French priests, American pathfinders, who in duty, necessity and joy used ice floes as ships, rode the river currents as steeds, wielded the forest fire as an axe, dynamite and mountain torrent as a shovel, until we have got into the habit of trusting to gifts, not trusting to ourselves, of deputizing the fight from our own hands and muscles to vast steam and machine equipment. And while we appropriate these titanic helps, gifts, and implements, we childishly squander our national resources in exchange for perishable luxuries supplied us by older and wiser men, corporations and nations who, not having gifts and prodigal equipment, still use their brains and hands—men who trade us sunshine, water, and air for our mined wealth, for our soil's fertility.

* "What do we want of the vast, worthless area, this region of savages and wild beasts, of deserts of shifting sands and whirlwinds of dust, cactus and prairie dogs? To what use could we ever hope to put these deserts, or these endless mountain ranges, impenetrable and covered to their bases with eternal snow? What can we ever hope to do with the western coast of three thousand miles, rock-bound, cheerless and uninviting, with not a harbor in it? What use have we for such a country? Mr. President, I will never vote one cent from the public treasury to place the Pacific Coast one inch nearer Boston than it is to-day." (Part of Daniel Webster's speech in Congress in 1844 against an appropriation of $50,000 to establish mail communication with the Pacific Coast.)

At the present market price of nitrogen, phosphorus, and potash, every pound of cotton that leaves our shores carries with it about $0.03 of soil value, every bushel of corn or wheat carries away about $0.20 of soil fertility. The nominal profit, about $0.03 a pound on cotton, about $c.20 a bushel on grain, is no greater than the market price of what is taken from soil value, and our agriculturist is devoting his great activity, his strenuous life of long hours, to the spending of his capital. The net income is nil.

In the industrial and financial world our four greatest living Americans, all men of extraordinary genius and ability, are: Andrew Carnegie who built up his gigantic fortune by coverting into iron and steel, and marketing them, the national resources in iron ore and coal; James J. Hill, who has capitalized his ability to stimulate the exhaustion of the northwest wheat fields and the Pacific Coast forests; J. Pierpont Morgan, who has marvelously stimulated and financed most of the great corporations existing for the destruction of inherited resources; John D. Rockefeller, who has carried good and cheap light into the hovels of China, of Africa, but who has poured out of America by barrel, by case, and by tank steamer, our lakes of petroleum that it took millions of years of sunlight and earth's internal heat and chemistry to accumulate.

We are nearly all of us engaged in similar work, and as has been said of babies, if our ability to exhaust and destroy were commensurate with our proclivities, the United States would before now have become an emptied shell.

The civilized European and Asiatic national policies are wholly different. They regard us much as the thrifty purveyors of amusement and debauchery regard the recent notorious paranoiac who squandered his inherited patrimony abroad, doing nothing of value with either hand or brain, sweeping all the glassware from a bar in a spirit of wanton destruction, oozing gold to those wiser and more cunning, more active in brain and body than himself, until broken in fortune, mind, and body, he ends his days in an asylum for the criminally insane. What a contrast between this man and the great European artists, Sarah Bernhardt, Paderewski, Caruso, and Génée, who, inheriting no fortune and with no equipment, depleting no national resources, using only brain and muscle, exchange their fleeting efforts for half a million American dollars apiece, which they take back to their native countries whence it flows again to us in exchange for our irreplaceable products.

Does the American paranoiac differ much from the American State of Nevada which a generation ago, in its golden youth, took $300,-

000,000 in gold and silver from the ground, exported it all for transitory equivalents, and then lapsed into a sparsely settled desert waste?

Switzerland was to Europe what the western deserts were to North America, a region destitute of national resources, but for centuries the canny Swiss marketed the fighting skill of their sons, who hired out in companies as guards for kings like Louis the XVI of France or as gateway guards for private palaces, until in French the word "Swiss" has come to mean "front-door custodian."

When the French revolution curtailed the opportunities for defending kings and palaces, the Swiss started in to market their wild scenery, to this end building good roads and good hotels, making visitors from all over the world come to their country. Up to this time the taste of the educated had been for flat, formal, conventional and tidy landscapes, mountains being held in horror. The Swiss also began to market little blocks of lumber for their weight in silver (after they had carved them by hand and brain skill). They imported raw materials from $20 a ton up, and they exported them again as watches worth from $32,000 to $16,000,000 a ton, the difference between import value and export value being Swiss brains and handicraft. A very high order of supernal common sense animates the Swiss.

No wonder that the former Senators from Nevada, Stewart and Jones, with their lives intertwined into a stupendous example of collective prodigality, experiencing in their own fortunes and activities its effects, studied more deeply the inter-relation of man, national resources and money than all the professors and statesmen of the eastern seaboard! Nevada can teach us more than one lesson. It was in Nevada that two pugilists, one black, the other white, by one hour's strenuous brain and body work before a moving-picture camera, produced pictures with a net export value of $100,000. We can achieve in America when we wake up, and if two of our citizens, Johnson and Jeffries, can manufacture in two hours' time export value worth $100,000, yet not deplete our natural resources, could not some of our other citizens of higher moral, mental, and financial equipment use a higher order of common sense and develop for export other products of American hands and brains? The depletion of Nevada was a very high order of near common sense. The production of exportable films of a prize fight is a very low order of supernal common sense.

There is another Johnson, Eldridge Reeves Johnson, one of the few exceptions in our millions, who, by means of a few cents worth of materials supplemented by American brain and hand skill is capturing the great singing voices, the instrumental bands, the speech of

great actors, and exporting disks at $5 each to the aggregate amount of millions. All honor to this exceptional man.

The table below, made up from figures in the June, 1910, report of the United States Bureau of Statistics, shows that one-half our imports consist either of articles of luxury, as silks, wines, diamonds, or of products that do not deplete natural resources, as rubber, sugar, chemicals, or manufactures of which the value is mainly due to highly skilled labor and delicate machinery, as cotton and linen lace, works of art and skill; and that our exports consist largely of prime raw materials, which deplete our natural resources, which are produced in vast quantities by unskilled labor aided by big and rough machines.

Even as to an item like tobacco, in which imports and exports are not far apart in value, imports were 46,838,330 pounds and exports 357,196,074 pounds, more than seven times as much in quantity.

IMPORTS.

Total Imports	$1,557,819,988
India rubber, unmanufactured	$106,861,496
Sugar	106,349,005
Silk	100,003,636
Coffee, tea, cocoa	94,242,360
Chemicals, drugs, dyes	90,964,241
Manufactured cotton	66,473,143
Manufactured fibers, linen, hemp, etc	57,624,245
Diamonds and stones	47,799,801
Tobacco, unmanufactured	27,751,279
Spirits and wines	23,384,133
Works of art	21,088,720
Earthenware, china and glass	17,574,890
Bonnets and hats	7,950,530
Toys	6,585,781
49.7 per cent. of total imports	$774,653,260

EXPORTS.

Total exports	$1,710,083,998
Raw cotton	$450,447,243
Animals, meats, leather, furs, etc., not including fish	199,996,328
Breadstuffs	133,191,330
Mineral oils and paraffin	106,976,571
Copper	88,004,397
Rosin, etc., vegetable oils and oil cake	54,412,275
Logs and lumber	51,852,136
Coal and coke	43,589,918
Tobacco, unmanufactured	38,115,386
Fertilizers	8,700,640
68.7 per cent. of total exports	$1,175,286,224

The exported materials, oils, metals, coals, can never be replaced; the exported lumber cannot be regrown in centuries. The imported silk, sugar, coffee, wool, tobacco and wines consist of brain skill, hand skill, sunlight, air and water; the chemicals are often high priced by-products which we waste; china, glass and laces are immensely valuable compared to the materials which make them, are therefore brain and hand products. Of the ten leading imported products, diamonds alone are lasting; all the others are fleeting luxuries, eaten up, drunk up, smoked up, worn out before the year rolls around.

Germany's governmental policy is to encourage the exports of brain, labor, sunshine, air and water; there is nothing in sugar, in alcohol, but carbon, gathered from the air, but hydrogen and oxygen gathered from the rain water, transformed by the sun into beet plants, grown in fields, tilled and wielded by hand, the beet pulp being transformed by other hands and skilled knowledge into sugar and alcohol. Denmark and Holland export butter which takes nothing from the soil. The French import Asiatic silk, weave it at Lyons, and export the finished product. They export wine, by analysis 87 per cent water, 10 per cent alcohol and 0.04 per cent aroma and bouquet. Water and alcohol take nothing from the soil, but the aroma makes the wine worth from ten dollars a pound down. In the peace negotiations between Bismarck and the French in 1871 it was not the money indemnity, it was not the loss of territory, that prolonged negotiations. Bismarck bethought himself to demand 5,000 empty old champagne barrels, impregnated with the aroma, the bouquet-producing ferment, and this the French refused. They had consented to pay $1,000,000,000, they broken-heartedly gave up Alsace and Lorain, but the bouquet of their priceless wines Bismarck should not have, and in the end they compromised on five barrels. The French were instinctively governed by supernal common sense.

America had great natural resources. The man who grabbed them first and fastest reaped the greatest reward. Tonnage, quantity, became a mania, men and equipment to produce tonnage have been the supreme aim. The American who killed the most buffalo for their hides, felled the largest tree, cutting to lumber only the main stem, pastured the most cattle on free government range, scooped or trapped the most salmon by current-turned wheels or other traps, has been a *quasi* national hero. Because these deeds were done by rifle, by steam saws, by cowboy outfits, by trap devices, it has became instinctive with us to exalt "tonnage" or quantity, to exalt equipment and to underrate organization. The instinct is there-

fore almost invariably to over-equip and to under-organize, to work with masses and aggregates rather than with details and ideals. Give the American a ton of dynamite and a mountain of rock and he is happy.

It takes neither much intelligence nor much labor to run a tunnel into the mountain, to excavate a chamber, to fill it with explosives, to turn on an electric sparker and blow the everlasting hills into the air, afterwards washing away the debris with a hydraulic jet. It was wonderful to make hydraulic mining pay for gold contents worth less than $0.05 per cubic yard, about one ten millionth part of the material, but there was another aspect. The hillsides were denuded, the lower rivers clogged, so that the issue between the farmers and hydraulic miners of California was a burning question for many years. Yet as we have seen, the farmer is worse than the miner. We can live without gold, but we shall starve on an exhausted soil.

Everywhere and always there is tonnage mania, and with it over-equipment of plant, too many men and prodigality of material. More capital is invested than is necessary. It is the material asset that appeals, not the greater value of organization and skill. Even a further step is taken and tonnage possibilities are converted into stock. I knew one captain of finance who capitalized the uncaught fish in the sea and persuaded Wall Street to underwrite the securities.

In field, in forest, in railroad operation and in manufacturing shops there is the same spirit of tonnage mania, lavish equipment, under-organization. It is good that the farmer transferred the bulk of his manual work to animals and more recently to machines. It is not good that his farm machinery, which ought to last with care for 40 years, is used only 30 days each year, is worn out and discarded in 5 years, after a total average use of only 150 days. One-third of the cost of harvesting and threshing wheat is the depreciation of the farm machinery.

From our forests we produced, in 1850, 5,000 million board feet, in 1909, 50,000 million board feet, a total of over 1,000 billion board feet, and a like amount has been wantonly or carelessly destroyed.

Railroad officials of the highest rank and largest experience have testified to the loss of ties by decay, to the waste of fuel, to the lack of interest of employees, to the detentions of freight cars, thus indicating inefficiencies of material, inefficiencies of labor, and inefficiencies of equipment, but thus far they have not ascertained with exactitude the extent of these inefficiencies nor their cause.

When for several generations our big activities have been built up on tonnage ideals, it will be exceedingly difficult and disquieting to change the destructive tendencies, and our whole industrial organization will have to undergo sooner or later the experience of a certain large shop. The company owning it also owned large ore mines, lake steamers, railroads, coal mines, river barges. The main business was originally to make iron and steel. To this end blast furnaces, converters, were built, and to keep them busy the contributory properties were secured. Each and every part from mine to mill finds itself operating on a tonnage basis. The easiest way to reduce costs is to increase tonnage, to put into operation larger and larger equipment. Purchasers wanting thin sheets and small rods have complained to me of the great difficulty of having their orders filled. There is no tonnage in such orders; they do not help the mine, the steamers, the railroads, the coke ovens, the furnaces, the rolling mills. To absorb the tonnage, manufacturing shops are started to convert shapes and rods into finished product, bridges or bolts, etc. One of these shops was selected for the application of efficiency principles. On time-study investigation the automatic machines were found to be delivering but 30 per cent of rated capacity, although the shop was on full time. By discovery of and elimination of the causes of stoppage, the output was increased to 67 per cent and it was then ascertained that working at 80 per cent of rated capacity the shop could turn out more product than required normally by the whole United States. The shop is now working less than half time and is producing more than it ever did before on full time.

As was formerly the case in this shop, "*the immediate*" has been mercilessly held up to every one connected with American work. A generation ago, all but a few of the railroad companies capitalized maintenance and declared dividends out of imaginary earnings. The immediate obscured the future. There has been an improvement at the top, but the minor officials still exercise all their best near common sense in realizing near ideals.

A number of years ago there was a great freight blockade extending west from Buffalo. Every western superintendent was instructed to forward no more cars. A local superintendent at Buffalo had gathered from far and near all locomotives, unreliable cripples as well as good power. The blockade became worse, as the cripples hindered the good locomotives even as women and children would hinder a regiment of marching soldiers. A high official was imported who made quick work of the trouble by sending the cripples away from the field of battle. When it became apparent that the blockade was soon to be

broken, word was sent west that on a certain date cars could be forwarded. A smart superintendent of a western division industriously collected all his locomotives, arranged long trains of freight cars in his yards and on his sidings, and when the hour came he forwarded an avalanche of trains and cars, clearing his own divisions, but hopelessly clogging the next one. As part of his plan he disappeared from his office so that he could not be reached by higher authority and his nefarious myopic zeal be thwarted. He made a tonnage record, he trusted to his equipment, he showed near common sense.

A railroad superintendent had occasion to send one of his locomotive to the central shops several hundred miles away for repairs. The locomotive was quite capable of hauling a two-thirds load, but this was not permitted and the locomotive was not even permitted to go under its own steam. It was put in a freight train and bumped over the road to its own detriment and that of the train and track. The superintendent was adding to his tonnage record. This tonnage mania is one of the curses of American practice. It had its value a generation ago when first erected consciously into an operating principle for blast-furnace output and freight movement by the great minds of Andrew Carnegie and James J. Hill, but it has wrought havoc when applied by lesser geniuses who forthwith, instead of thinking and planning and organizing, clamor for more equipment. The epidemic of broken rails which discredited the Bessemer process and against which railroad executives combined in protest was brought about by the tonnage mania, by the use of piped ingots and few passes. The physical and pschyical sledge-hammer blows of Mr. J. W. Kendrick demonstrated the rottenness of the rails.

On one of the great transcontinental lines a gravity grade was eliminated at a cost of $5,000,000, entailed a fixed charge forever of $1,000 a day. The operating cost of the helper locomtives able to handle all the traffic up the grade did not exceed $100 a day.

In the foundry of one of the large Pittsburg machine shops, the castings for a large engine are made. Eighty per cent of the weight and forty per cent of the work occurs in three or four pieces, the fly wheel, the bed, the cylinder. On the next fifteen per cent of weight there is another forty per cent of work, and in the final five per cent of weight there is twenty per cent of the work. The founder, aiming at tonnage, molds the big pieces and then clamors for more work, urging the starting of another engine. When the engine parts reach the erecting floor it proves almost impossible to

secure the five per cent of missing small castings, involving per ton eight times as much work as the larger pieces.

A structural shop orders the supplies from a rolling mill. The big beams are promptly shipped, because they add to tonnage. The angles and smaller pieces do not come for weeks or months. The superintendent of the structural shop pleads for permission to begin work immediately on material not deliverable for three months. He also has a greedy eye on tonnage. If permitted to do the work ahead of time he clamors for permission to ship it. He is always ahead on big work, always behind on small work.

In a machine shop it is ascertained that a big machine, a flange furnace, a bull riveter, a wheel lathe, can do certain classes of work in shorter time. Very seldom is a careful study made of the yearly cost of operating and maintaining the desired machine, or of the quantity of work that can be diverted to it, or the disposition that is to be made of the displaced machines. The efficiency of the existing machines and men is never ascertained, because there are only a dozen shops in the United States in which any scientific standards of men and machine efficiency exist. The old machines may be working at 60 per cent efficiency, with a standardized cost of $0.90 an hour for machine and man. New equipment costing $10,000 is ordered, with a yearly machine rate alone of $5,000. If the machine is used 2,500 hours, the hourly rate will be $2.00 an hour. The probability is that it can be used only 1,250 hours in the year. This makes the actual hourly charge $4.00 an hour for work which had been taking twice as long at 60 per cent efficiency and at a cost of $0.90 an hour. At 100 per cent efficiency it would have taken only 20 per cent longer time than on the new machine, the relative costs varying as $1.08 on the old machines to $4.00 on the new.

In a plant a new $8,000 machine was ordered by the office because it was believed that certain work was not being delivered fast enough. It was found that the old machine was only working less than three hours a day. Had the new machine been bought it would have increased permanently the operating costs of the company about $4,000 a year.

In over-equipped plants (most plants are over-equipped) if there is an expensive machine capable of working only a few weeks each year, the work is not to be charged with the tremendous hourly rate required to carry the machine. A legitimate hourly rate is based on the assumption that the machine works full time and the idle hours are charged to overhead expense. The aggregate of these wasteful overhead expenses is very great. It is common sense, the high-

est kind of progressiveness, to install a machine that can cut down the time of work to one-half, and this kind of common sense is peculiarly American, but usually the increased equipment is not yet needed, existing equipment is inefficiently used owing to under-organization, and the ill considered additions are due to the national reluctance either to think or to tire muscles.

The traffic manager of a great railroad apprehends a prospective 10 per cent increase in business several months ahead. He immediately insists on additional equipment, 100 more locomotives and 4,000 more cars, and no one stops to ascertain whether existing equipment is working at more than 60 per cent efficiency. On the basis of past experience the increase is justified, but there are many instances in which equipment takes the place of business, as in the case of the boy who, starting a lemonade stand, does not feel himself equipped for business until he is provided with patent lemon squeezers, ice pulverizers, strainers, patent vibrating shakers, a $50 outfit, from which with great loss of time he produces semi-occasionally luke-warm, watery lemonade in dirty, sticky glasses. He has neither organization, ideals, nor common sense, and so, in his humble way, he tumbles into the mistake of over-equipment, carrying out the national proclivity which prevents us from giving to great industrial problems and questions as much time and analytical thought as a good chess player gives to his game.

The American, from presidents of the United States or of great corporations down to cubs in office or shop, in spite of his natural mother-wit, finds himself struggling against quicksands of tradition, whirlpools of immediate necessity, fogs of current practice, of near common sense; and each is in the condition of the great condor, the most skilled of all flying birds, whose nest and starting ledge is in the face of high cliffs, but who, once on the ground, in a fifty foot circle surrounded by a ten foot fence, is less able to rise than a barnyard chicken.

The elimination of waste through the application of the efficiency principle of common sense is a more difficult task that the elmination of waste from gold-mining operations by the use of better processes. Better extraction from ores, better exploitation of mine tailings, is easily attained by the use of better methods, which do not in any way clash with the training, ideals and conceptions of a progressive manager.

Better methods and processes, however important, are a minor part of one single efficiency principle, the standardization of conditions; but to apply all the principles, a manager must be born again,

forgetting much that he thought of value, adopting, adapting, becoming adept in new lines of thought. At the start he finds himself enmeshed in an offensive, destructive type of organization which he must use an unfamiliar common sense to modify and remake into a defensive, upbuilding type. Even if he is in a position of highest authority at the top, this is not easy as he must run counter to most of the ideals and life-long practices of an extended line of subordinates. If he finds himself many steps below the top, he is indeed caught between the upper and nether mill stone, for those above him will treat his suggestions with impatience and skepticism, those below him will meet them with rebellion. Even if he succeeds in making his organization constructive, he must again use an unfamiliar common sense to overcome in himself and others a long series of vague, discordant, at best opportunist and near ideals, substituting for these, not utopian and unrealizable, but wordly-wise standards as high as the particular activity will commercially stand.

If a manager has succeeded in modifying the organization, if he has succeeded in emphasizing the governing ideal so that all may understand it and work for it, he suddenly meets new difficulties probably from both customers and government who will make the occasion of his efforts to eliminate waste, to make better use of materials, of labor, of equipment, an excuse to demand a physical valuation of the material property as a basis on which to regulate freight rates or other charges, thus imposing a direct penalty on efficiency.

It is impossible to lay down rules or to give specific directions as to how we shall convert prejudice and ignorance from without, near common sense within, into supernal common sense.

Near common sense binds to the centre of a sphere. Supernal common sense may, like a star, survey the centre from any part of the vault of heaven, but the twelve principles of efficiency, like the twelve signs of the zodiac, divide the heavens into twelve parts, thus giving us twelve different directions of attack on inefficiency.

To select an upbuilding constructive organization, carefully to determine and adhere to ideals, constantly to survey every problem from a lofty instead of near point of view, to seek special knowledge and advice wherever they can be found, to maintain from top to bottom a noble discipline, to build on the rock of the golden rule, of the fair deal—these are the general problems which supernal common sense must immediately solve. It will perhaps prove more difficult to remedy the evils of over-equipment, the direct result of an elementary organization accustomed to deal with great natural resources.

GOVERNMENT SPECIFICATIONS. AN EXAMPLE OF NEGLECT OF THREE EFFICIENCY PRINCIPLES.

By F. Percival.

The author of this article is intimately familiar with his subject. His contribution, received some time ago (in fact, shortly before the commencement of Harrington Emerson's series on the "Twelve Principles of Efficiency"), is presented as the first of a parallel group exemplifying, by independent testimony from practicing engineers in various fields, the universality of these principles and the specific effect of their observance or their neglect. The present paper points out the injury—the inefficiency—arising from non-observance of three of the Twelve Principles: Common Sense, the Fair Deal, and Expert Advice.—THE EDITORS.

IT is safe to say that one-half of the cases before the United States Court of Claims are due to poorly prepared contracts which have their source in faulty specifications. Furthermore, not less than one-third of the cases brought before the Comptroller of the Treasury are due to the same source. When one stops to think of the great cost to the United States brought about by lack of care in preparing specifications, it seems unreasonable that steps are not taken to correct the condition.

No doubt much of the fault lies in the fact that Government specifications are prepared by inexperienced men; that is, men who lack practical business training—men who, certainly lacking the "supernal common sense" defined by Harrington Emerson elsewhere in this issue, and largely lacking even "near common sense," in their zeal to cover every point, go beyond reason in their demands. The specifications are too one-sided, and the requirements often so poorly expressed as to permit of various interpretations. It frequently happens that the successful bidder may have had one idea when preparing his bid on a certain piece of work, whereas, if a narrow-minded inspector be on the job, the contractor may be required to place the work in a manner which will cost him thousands of dollars more than the price bid. When there are commonly accepted methods for doing work, those methods ought to be specified; but if deviations are to be required that fact should be clearly stated in the specifications. This would give bidders an opportunity to prepare their bids accordingly.

Here is a case in point: A firm after submitting the lowest bid for building a power house was requested to revise its bid so as to bring the total cost within the amount allotted for the work. The firm complied; but during construction the inspectors were more than exacting in their demands, and finally, after the switch boxes, etc., had been installed according to contract, requested that the boxes be removed and new ones placed so as to meet the requirements of the State (Pennsylvania) underwriters. The contractors say that that change alone cost them more than two hundred dollars. When asked why they did not appeal, they said: "Our retained percentage would have been held up, and we needed the money; furthermore, the amount was too small to employ a representative, although it practically wiped out our profit. Instead of showing us some consideration, the inspectors put the strictest interpretation on the specifications." It is a fact that that firm always bid high on Government work thereafter—unreasonably high.

Another case was that of paving the river bank near Marietta, Ohio. In this case the specifications called for riprap, but on the drawing showing the paving in place there was noted that a corner should be cut from each stone. In getting out the stone the contractor ordered rectangular blocks in accordance with the specifications; but before he could lay them he was required to cut off a corner from each stone.

A contractor receives very little consideration in such cases. He must either accept what is allowed him, or he must sue for his rights. Of course, there is the Comptroller of the Treasury, but it is not always safe to go to him. Many contractors have the impression that it requires legal counsel to present a claim, and the amounts involved do not always justify such expense. Take the case of the switch boxes; had the contractors refused to comply with the demands, the contract would no doubt have been annulled and the retained percentage would have been "tied up" until the work was completed. Should the contract have been annulled, the Government would have either completed the work or had it completed, and the contractors would have been forced to stand any additional cost incurred. Or they could have completed the work and sued for their claim for extras. In that event they would have had to employ an attorney, and perhaps wait from three to six years for a settlement. This simply goes to show that after a man has entered into a contract with the Government, the inspectors and officers can either

"make or break" him. It shows that provision should be made to compel the exercising of great care in preparing Government specifications, not only for the protection of contractors but for the protection of the Government itself. It is not believed to be the intention to have work done in excess of what the contract calls for without paying for it; but it is known that inspectors have been overzealous and have caused contractors needless expense and loss, and that they have erred on the other side also.

Often Government specifications call for grades of material, special tests, etc., that are never furnished nor asked for. Only the experienced contractor understands how to have such requirements waived; and it is those men who are successful—who make money. But even they miss it. Think of what it costs the Government when special requirements are waived—they are never waived until after a contract has been entered into. Some time ago specifications for white oak required that the timber be practically clear. There was not a bidder who did not express the opinion that such timber would be very expensive should anyone be able to furnish it at all. While the successful bidder quoted a high rate, the timber was not furnished according to specifications—it was not clear oak. Had the specifications provided for oak of the grade that was accepted, the Government would have received equally good material at a saving of at least $20 a thousand.

No Government contracts or, for that matter, contracts for any public work, should be, nor can they be, awarded as is work for some of the large corporations. Public work should be let on carefully prepared specifications, and to the lowest responsible bidder, without trying to beat down the prices after the opening of proposals as has been done by some of the large corporations. But it is imperative that all public-work specifications be carefully prepared from every point. The spelling, sentence construction, use of words, and requirements should be carefully considered in each case. Government specifications err as a rule on the side of unreasonableness—often the requirements can not be met.

How for example can such statements as the following be reconciled:

One paragraph provides "Sub-contractors, as such, will not be recognized."

Another paragraph of the same specifications provides in case of annulment of the contract "the United States shall have the right to take possession of * * * any or all sub-contracts * * * and

to pay for them * * * at a valuation to be determined by the Engineer * * *. In case any * * * sub-contracts * * * are taken possession of by the United States * * * it is understood and agreed that no payment therefor shall be made until the work has been completed."

Sub-contractors will not be recognized; but without consulting the sub-contractors they must furnish material, etc., and wait for payment until the contractor's work is completed. The fact that such documents are contracts and provide requirements for each party thereto is ignored by the agents of the Government. Under what circumstances can the Government require a man to fulfill a contract without meeting the other party's obligation under the same contract? Under such a requirement would a Government agent have authority to make payment, in case of annulment of original contract, if material had been furnished under a sub-contract? If not, how would a man of small means be able to obtain payment? He could not afford to bring suit, the amount being generally too small; and he could not, without undue hardship, wait so long for payment. Such requirements are detrimental to the service.

Here is another extract from Government specifications for machinery:

> When funds are available, payments on each lot will be made monthly for material delivered at the site and accepted, as follows: 40 per cent for raw material; 70 per cent for machinery or structural steelwork ready for erection; 90 per cent for completed work; and the full amount upon completion of the contract.

How much was the contractor for the machinery entitled to under that provision? It appears that if he took advantage of each payment provided, he would receive 260 per cent; that is, 70 per cent on delivery, 90 per cent on completion of the work, and 100 per cent on completion of the contract. Furthermore, what is the "completion of a contract?" Does it mean when the contractor has completed his work; or does it mean when both parties to the contract have fulfilled their obligations thereunder? If the latter, when would the contractor receive payment?

What would be the chances for a contractor in the hands of an unreasonable inspector under the following provision:

> Incidentals; minor items of material and work not otherwise provided for; temporary work, material, plant, and tools; assumption of risks; and other expenses and losses incident to carrying on the work shall be

covered by the rates or prices bid. Everything provided for in the specifications or shown on the drawings shall be completed, furnished with all necessary and usual accessories, and put in good condition and working order.

Would any court uphold the demand for carrying out the first part of the above provision? If not, why fill specifications with such "stuff"? It is just such requirements that keep competent and responsible men from bidding on Government work.

Uniformity in Government specifications is unknown, and as a rule those specifications are conspicuous by the absence of generally accepted understandings—trade terms. Is it impossible for the Government to adopt certain specifications for timber, iron, steel, stone, and the like? Such specifications could be standardized and would greatly facilitate work, especially in the Engineer Department of the Army. That Department has already adopted specifications for cement; but requirements of those specifications are frequently waived.

In measurements of material and work, why should the Government have different methods from those generally accepted? Do they help anyone? Take the following:

Except as otherwise provided, measurements for unit-quantity payments will include only finished material forming part of the permanent work, actually in place and accepted.

Does not that paragraph make provision for the deduction of bolt holes in timber? For example, if a contractor furnish a stick of timber in accordance with the specifications, and holes are required for anchoring, can not the inspector make deduction for the timber removed in drilling the holes? When such provisions are made, a bidder owes it to himself to quote prices accordingly; he can never tell to what extreme an inspector will carry the matter. Would not the Government profit by following regular business practice in such cases?

It is a well-known fact that it is quite a simple matter to find errors in the work of others. But how are such errors to be avoided? By employing competent, practical men. With the large amount of work done under contract, the Government should have little or no trouble in issuing specifications under which a man can do good work at a reasonable price.

In the first place a board should be appointed whose duty it should be to consider thoroughly every set of specifications before

they are issued. Such board should be made up of one man from the Department of Justice, a man from the Treasury Department, a man who is well schooled in the use of the English language, and a man from the department under which the work covered by the specifications is to be done. Business terms where applicable should be used, and the practice among business men should be followed whenever practicable. When special requirements are necessary they should be clearly expressed and adhered to. Government work should be among the best in every detail, and the Government should receive what it pays for; but it should set forth plainly and in no uncertain terms what is required. Specifications for public work should be statements of what is wanted; they should be brief and to the point; they should be models in clarity of expression.

TIME-KEEPING AND LABOUR DISTRIBUTION IN THE FOUNDRY.

By Victor R. Claydon.

IV. OBTAINING TRUE COSTS OF CASTINGS.

Mr. Claydon's series began in May last, and has continued throughout the summer with the exception of our August issue, when it was interrupted by the illness of the author. This month's instalment concludes the discussion, which throughout is addressed to the modest establishment requiring adequate and reliable records with the minimum of clerical work and expense.—THE EDITORS.

THE purpose of this concluding article is to endeavor to bring together, in as concise a manner as possible, the numerous divisions that go to make up our final cost reports. One might very easily fill sheets of paper elaborating each of the various items composing these reports, but my idea is rather to consolidate the information at our disposal, and set out just those pertinent facts which will give the true conditions of our costs, and enable the management to rectify any defects that may from time to time be shown up in the various reports.

In the preceding articles on labour distribution and stores I endeavoured to show how the labour and material might be consistently apportioned to the various shops to which they belong, thus making a shop burden for each department.

Before our final reports can be made up, however, there are one or two points on which it might be well to touch, and in the first place let us look at our invoices. I have previously spoken of these invoices which are debited to our stores, but in addition to those, there are numbers which can be charged either direct to our staple lines of manufacture or to the particular job on which they are used. For example, we might charge nickel door handles for furnaces directly to that account, or we might charge a steel beam to a machine-shop repair, as we are in a position to know that this particular beam was bought and used for that specific purpose, and by this means we obviate the necessity of a bulky stores ledger. When we know that a certain line of goods is bought for, and used exclusively on, any particular line of castings, it is just as well to place such invoices to the debit of that article instead of the matter having to pass through the storekeeper's hands two or three times.

It has been already pointed out that these articles are not addressed to such plants as have an elaborate system in force, but rather to the young plant which as yet has no particular system, but knows that one is required, and is consequently seeking some ideas which will give practical results without an excessive cost.

To deal with all our invoices in the way outlined hereunder will I think give us the information necessary for the apportioning of expenditures to the several accounts to which they are chargeable. As soon as any invoices are received by the purchasing agent, he should at once mark them as chargeable to certain account numbers, according to the classification of accounts we have in force. At the end of the month these invoices should all be gathered together and entered in an invoice record book, and the various items charged out in the distribution columns of this book according to the classification made by the purchasing agent. By this means our stores-ledger clerk is enabled to get the exact amount of the invoices that should go through his stores ledger for any particular month, and at the same time he can obtain the total amount of invoice burden chargeable to each shop, and charge it on his burden reports.

Another point I think worthy of consideration is the following: In order to illustrate better how errors and defects occur and are treated, let us assume that a large cored casting has been found defective, and when the piece was broken up for examination it was found that it was the moulder's fault that the casting turned out bad. In this event, presuming the moulder and core maker to be both piece-work men, although the moulder would not get paid for this bad work, yet the core maker would have to be paid, so that this amount would have to be charged to our "Errors and Defects" account. Such instances as these, however, do not constitute all our errors and defects. It happens quite frequently that even after a casting has been sold and delivered to a customer it will be returned by him as defective, for some reason which could not be detected in the shops; hence it will be necessary for us to go to our credit book each month and place in our burden accounts all the charges made against errors and defects. It will happen, perhaps, in some months that this amount will be quite a large sum, or *vice versa*. It is, however, of sufficient importance to need very careful looking after.

Having now obtained sufficient information on which to start our final cost reports, let us glance at the various reports we shall find it necessary to make in order to arrive at the true cost of our marketable product of each class of castings manufactured. Our first consideration, then, will be our Foundry Cost and Production Report,

which we will divide as follows: "Cost," left-hand side of form, and "Production," the right-hand side. On the left-hand side, then, we shall enter the various grades of pig iron and scrap with the quantities of each used, extending each class out at its respective price per ton. On completion of this we have the cost of our gross melt, but this by itself is of no avail, as it stands to reason we must credit our gross melt with all the sprues and gates and bad castings made during the month, as obviously all these go back to the cupola for remelt. After deducting this amount from the cost of the gross melt we have the cost of our net metals used—or, in other words, we have that amount of money which when divided by the quantity of good castings produced will give us the price of our iron for one pound of saleable product. This, then, is our starting base. Having arrived at this cost, our next point is to enter on this sheet our direct labour on the several classes of castings manufactured, both for moulding and core making, and any other direct labour we may have in the foundry, and by dividing this total by the quantity of good castings we arrive at the direct-labour cost per pound of good castings. It must be borne in mind, however, that when working out the cost of direct labour per pound for core making, the amount must be divided by the weight only of good *cored* castings produced; hence it will be necessary for us to keep these weights separate in our "daily record of production" book.

The remaining portion of the left-hand side of our report is devoted to the several divisions of burden which we have to obtain from our foundry and core shop burden reports; but before dealing with these we will glance at the right-hand side of our form, *viz.*, "Production," and see what subject matter is required to complete this. As on the cost side of this form we started with the items composing our melt, so on this side we start with our production. From our "Daily Production Record Book" we should be in a position to obtain the total weight of each class of castings produced, both good and bad, these in turn each being subdivided into plain and cored work. These respective weights should be totalled and the totals enumerated on our production report under the respective headings of good and bad castings. In addition to these, we should also enter the weight of our sprues and gates produced. The total of our good and bad castings with the sprues and gates will therefore give us what we actually received for the amount of metal put in cupola (see opposite side of report). By deducting this total from our gross melt we arrive at our shrinkage (or loss in melting) and the whole added together will balance our gross melt.

Of course this form can be very much elaborated to suit the requirements of the management. For instance, we can add items of general importance, such as the amount of metal melted with one pound of fuel, etc.

We will now turn to our Foundry Burden Report, as it will be necessary for us to have these figures before we can complete our Cost and Production Report. In a previous article I gave the different divisions that go to make up this report—that is, the items which should be distributed on the basis of tonnage and those items which have to be distributed on the amount of direct labour expended. In September, 1909, I wrote an article for this magazine on the subject of the "Proper Distribution of Foundry Tonnage Burden," the point of which was that in order to apportion these burdens accurately it was necessary that the total burden should be distributed on the total weight of good and bad castings produced, for the reason that in the event of any particular branch of our business suffering big losses the onus would be put on that department and not spread over the other branches of our business, which had nothing whatever to do with the losses in question.

I do not think it would serve any purpose to illustrate any form on which all this subject matter can be drawn up, as with each foundry the nature of the information required varies very considerably; and these matters are best determined by the officials requiring the information. However, the theory is just the same, and with such modifications as may be deemed necessary, suitable forms could very easily be drawn up. As a suggestion of the principal burden accounts requiring careful handling the following I think are the chief: Cupola Labour and Repairs, Ladle Expenses, Renewals of Flasks, Cleaning and Chipping, etc., these being tonnage charges; and then again in our direct-labour section it will be necessary for us to keep track of such items as Maintenance of Buildings, Machinery, Tools, etc.; also general Shop Expense, which as I have previously stated can all be subdivided into any divisions found necessary in the working out of our system. In addition to these, and before our burden report can be completed, we will still have to enter what I will term our "Administrative Distribution Burden." This expense is composed of the proportion of salaries of officers chargeable to the foundry, and our proportion of the head office expenses, rent, rates, taxes, depreciation, etc., and these can be only gathered from a general burden report (which I will deal with hereafter), and then pro rated over the various shops. As soon, then, as this information has been compiled, we can carry our total foundry burden of each class of castings to our

Cost and Production Report. Our core shop being an adjunct of the foundry, it will be necessary for us to carry an adjunct of the Foundry Cost Report. (This Burden Report will contain only our core shop expenses, and will be distributed on the weight of good cored castings produced.)

Having now all our information correctly recorded, we can very easily ascertain and enter up the cost of each class of castings in the foundry (or at the machine-shop door).

Our next step then is to arrive at our machine-shop cost, and here we have no tonnage burden to contend with. From our machine-shop labour distribution (explained in a previous article) we are in a position to get our direct charges for this shop, and also the burden charges, which have to be distributed to the several classes of castings on the percentage of the direct labour on each. In all probability we shall find our machine-shop burden much higher than the foundry for the reason that we are bound to have much more indirect labour in this shop. All our pattern renewals are chargeable to the machine-shop burden, and one can readily understand that in a plant of any magnitude this is no small item. The burden report may be conveniently itemised in the following manner:

Renewals of Patterns, Wages and Materials. Maintenance of Buildings, Wages and Materials. Maintenance of Machinery, Wages and Materials. Maintenance of Tools, Wages and Materials. General Shop Expense, Wages and Materials.	Distribution columns to several classes of castings.

and in addition there will be the machine shop's proportion of the administrative distribution burden.

As a general rule I would suggest that the wood-pattern shop be kept a separate department, and capable of carrying its own burden. I believe in some plants it has been the custom to join this with the machine shop; but I venture to think that it is the wiser plan to have them separated. It is a shop by itself—that is, its work has but very little bearing upon any of our other shops, its principal work being of course the making of new wood patterns and repairs to wooden flasks, etc. A form similar to the machine-shop burden form can be used for this.

We have now to consider our General Burden Report, and as its name implies this is a report in which those charges are recorded that belong to no particular shop, but are a burden on the whole plant *pro rata*. And the first item of this nature is our power and water. We will assume we generate our own power. In order, then, to arrive at the cost of this, it will be necessary for us to keep track of the coal

used in our boilers, and the cost of this should be charged through our stores ledger. It will also be essential that our electrician furnish us with the correct percentages of power used in each of the various shops, not only for lighting, but for elevators, cupola blowers, etc. In addition to this we must see that the wages of our electrician, engineer, fireman, and any of their assistants are correctly distributed. With this information, then, we can obtain the total cost of our power, and apportion it to the various shops according to the figures given us by the electrician.

The next item we will call General Shop Expense, and this consists of those many little incidentals which crop up, and which it is impossible to charge to any particular shop. Under such a category as this we might put our watchmen.

A third item in connection with this report will be our warehouse expenses, whilst another will be our clerical help; and finally there would be our rent, rates, taxes, depreciation, etc., and in fact all those factors which go to make up our office expenses. As soon as all this information has been detailed, we shall then have to pro rate the total over the several shops. It will then be necessary only for us to make a summary of each of our reports from which we shall be able to arrive at an accurate cost of our saleable product for each class of castings.

Obviously this is only a brief outline of the method by which all our costs are concentrated, but I trust it will be sufficiently explicit to give a clear outline of what is required in the accurate determination of costs. As I have previously stated, elaboration can very easily follow. The main point is to have a cost system, and a real live one at that. Let what you undertake be thorough, otherwise your results will not be of much account. One writer has well said that "all our accounting arrangements no matter how elaborate, or how carefully planned, can only *show* results, not *produce* them." At the same time it must not be thought that the cost system is a secondary consideration, but productions and costs should go hand in hand, as it is only by such co-operation we are able to point to defects and use the best means at our disposal to remedy them.

In conclusion I would urge the necessity for the speedy compiling of costs each month, as very often if any length of time has been allowed to lapse before calling attention to weaknesses shown up in our reports, the opportunity of remedying such evils has slipped by.

THE HEATING, VENTILATING AND AIR-CONDITIONING OF FACTORIES.

By Percival Robert Moses.

II. THE REGULATION OF HUMIDITY, AIR WASHING, AND COSTS.

IN many processes of manufacture, the regulation of humidity is of more importance than the heating of the building or the ventilation of the building.

In spinning or weaving mills, the question of heating is of comparatively little importance, because the operation of the machinery generates more heat than is necessary to take care of the building losses. The presence of too dry air, however, induces the development of static electricity, because it is a poor conductor, reduces the tensile strength of the fibre produced, and decreases the value of the product. The same is true in silk manufacture, and it is almost impossible to secure an evenness in texture without the regulation of the moisture in the air. In some processes, dry air is required, such as in steel manufacture, where the removal of moisture from the plant results in a great economy in the production of the steel and a marked improvement in the quality of the product, particularly as to its uniformity.

The subject of the humidifying of air is of extreme interest and it is absolutely bound up with the control of the temperature. It may be well to say a few words regarding the general subject of humidity. For every temperature of air there is a corresponding quantity of moisture which will be carried in each cubic foot without precipitation. The quantity carried increases with the temperature, as follows:

GRAINS OF MOISTURE PER CUBIC FOOT IN SATURATED AIR.

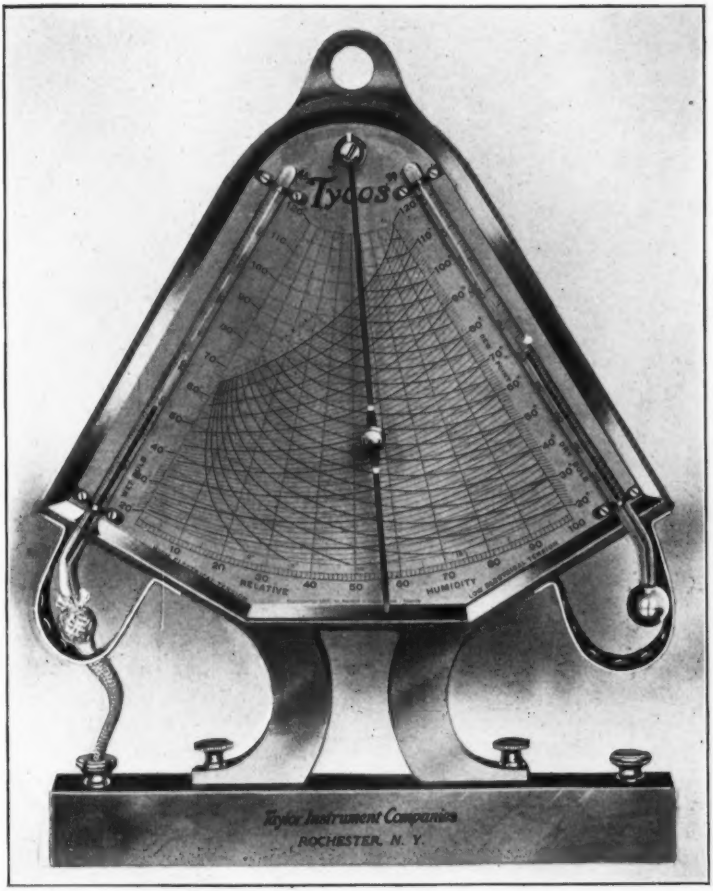
Dry Bulb Temp.	Grains.	Dry Bulb Temp.	Grains.
0 F.	0.48	65 F.	6.78
10 "	0.78	70 "	7.98
20 "	1.24	75 "	9.36
30 "	1.94	80 "	10.93
40 "	2.85	85 "	12.74
50 "	4.08	90 "	14.79
60 "	5.75	120 "	34.80

At 120 degrees F. a cubic foot of air will carry 34.8 grains of moisture. If, therefore, air at 120 degrees were introduced into a room in a saturated condition and were allowed to cool to 70 degrees, nearly 27 grains of moisture would be deposited for every cubic foot of air thus introduced, or one pound for every 260 cubic feet; and, *vice versa,* if air at 70 degrees were introduced into a room and allowed to heat to 120 degrees, instead of being in a saturated condition, as it was at 70 degrees, it would have less than one-quarter the quantity of moisture it is capable of carrying.

The relation between the quantity of moisture actually contained in the air at any given temperature and the quantity of moisture carried at the saturation point for that temperature is called the "relative humidity." This relative humidity is indicated by the difference between the temperature shown by a wet-bulb thermometer and a dry-bulb thermometer, or as shown by the hygrodeik.

Tables showing the ratio of wet-bulb temperature to dry-bulb temperature, known as psychrometric tables, show that for any given percentage of humidity within a temperature range of 20 degrees F. the ratio of the wet-bulb temperature rise to the dry-bulb temperature rise is practically constant. This approximate uniformity of difference for a stated degree of humidity is taken advantage of in one system of regulation to permit the regulation of the humidity and its maintenance at any desired amount. With this system, it is desired, for example, to maintain a humidity of approximately 70 degrees. A humidity of 70 degrees is equivalent to a difference between the wet and dry bulb of from 5 to 7 degrees. Hence, if by some means, the temperature in the room to be humidified can be kept at from 5 to 7 degrees above the temperature of the saturated air delivered from the humidifier, the resulting saturation in the room will be 70 degrees. The means adopted for maintaining the difference between the temperature of the air in the room and the temperature of the air issuing from the humidifier is to open and close the damper admitting the supply of heated air in winter or cool air in summer, and thus by regulating the quantity of saturated air delivered regulate the temperature of the room.

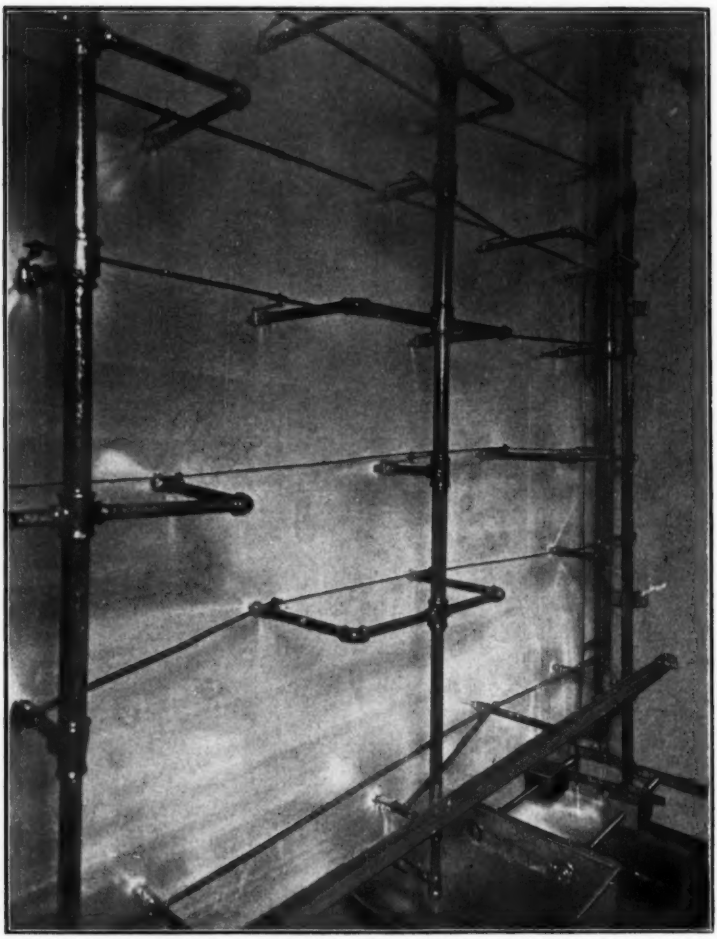
The necessity for a constant difference in temperature also introduces the requirement that in winter, when the temperature of the room must be maintained at about 70 degrees as a minimum, the temperature of the air when it is being saturated must be between 64 and 65 degrees. In order to obtain this temperature, it is necessary to heat the air. This is done in this system by allowing steam to mix with the water in the humidifying chamber. The steam is automatically



THE HYGRODEIK, FOR MEASURING THE RELATIVE HUMIDITY OF THE AIR.

shut off as soon as this water reaches the desired point, 64 or 65 degrees; as soon as it falls below the desired point, the steam supply automatically opens up.

Another condition demanding attention arises from the fact that in winter when the temperature of the room rises, as it does in the operation of machinery, and the temperature of the saturated air remains approximately at 64 or 65 degrees, it is necessary to decrease the amount of heated air supplied for ventilation and heating, while in summer time, when the supply is cooler than the air in the room,

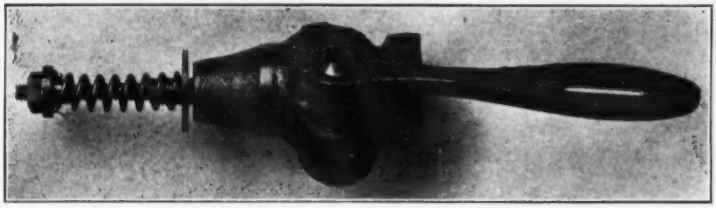


THE KINEALY AIR HUMIDIFIER, SHOWING SPRAY HEADS IN ACTION AND AUTOMATIC CLEANING DEVICE.
Kauffman Heating and Engineering Co.

it is necessary to increase the quantity of air supplied in order to decrease the room temperature and maintain the required difference in temperature. It becomes necessary, therefore, for the automatic thermostats which close the dampers to operate in one direction when the temperature of the air delivered to the room by the duct system is higher than the temperature of the air in the room, and in the other

direction when the temperature of the air is lower. This operation is carried on by what is known as the differential thermostat.

Another method is to use an intermittent system of humidifying, the spray being turned on and off as the relative humidity rises and falls. There are other systems of localized hanging humidifiers with and without fans, but these do not control the temperature, hence do not accomplish fully the result considered in this article.

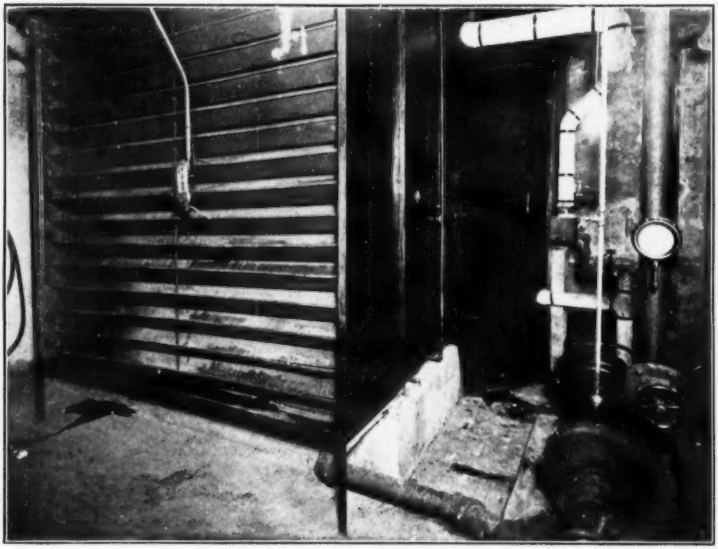


LATEST TYPE OF KINEALY SPRAY HEAD FOR AIR HUMIDIFYING.

The regulation of humidity has also a commercial value in addition to the value arising from betterment of product and more uniform quality. Wherever textile yarns or similar material is sold by weight, the percentage of moisture has an important bearing on the results. Standards have been fixed as to the allowable amount of moisture, this amount being determined by the difference in weight between a sample dried in an oven and a sample as delivered. If a manufacturer delivers yarns or other material with less than the allowable percentage of moisture, he loses a legitimate amount of profit. This percentage of moisture is known as the "regain." The usual allowance varies from 8½ per cent with cotton to 17 to 18¼ per cent with wool. If the relative humidity in the mill is maintained at approximately 70 per cent with 70 degrees temperature, 73 per cent with 80 degrees temperature, 76 per cent with 90 degrees temperature, it is found that the amount of regain is about that allowed. If the humidity falls much below this, the amount of regain will be correspondingly reduced and the manufacturer suffers a loss, besides a loss in the value and strength of the product.

A series of tests made by Mr. J. H. M. Beaty, of Clemson College, South Carolina, showed that with 25 s yarns a reduction from 84 per cent relative humidity reduced the strength of the yarn 11.4 pounds; with 30 s yarns, a reduction from 95 per cent to 46 per cent reduced the strength of the yarn 19.2 pounds. It was also found that the percentage of broken ends is less with the higher percentage.

In hot summer weather, it is possible to cool down the incoming air from the temperature outdoors to the wet-bulb temperature, usu-



ELIMINATOR SIDES, KINEALY HUMIDIFYING INSTALLATION.

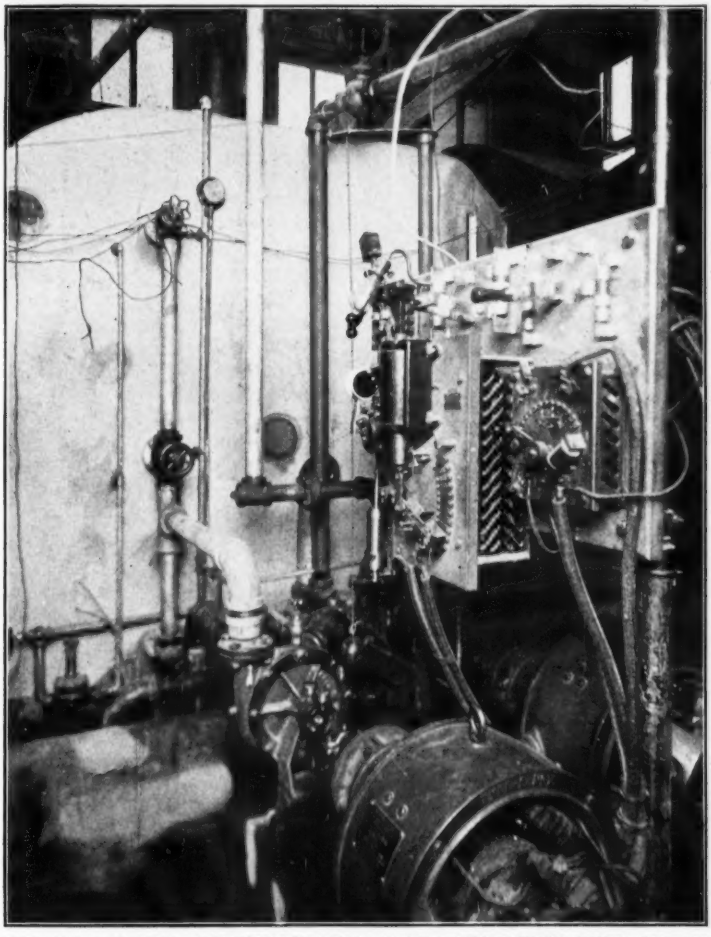
ally 10 to 14 degrees below the dry-bulb temperature outdoors. This air delivered to the mill is heated up by the heat from the machinery and a sufficient volume of incoming air is delivered from the humidifier to keep the temperature down to the difference required for maintaining the required amount of humidity. As it will be found that the amount of air required for this purpose is far in excess of the amount of air required for ventilation in winter, the ducts must be proportioned for summer work.

The extent to which these systems are carried may be inferred from the size of plant recently ordered for a large New England mill, where 412,000 cubic feet of air per minute are to be delivered. This mill is 360 feet by 133 feet, six stories.

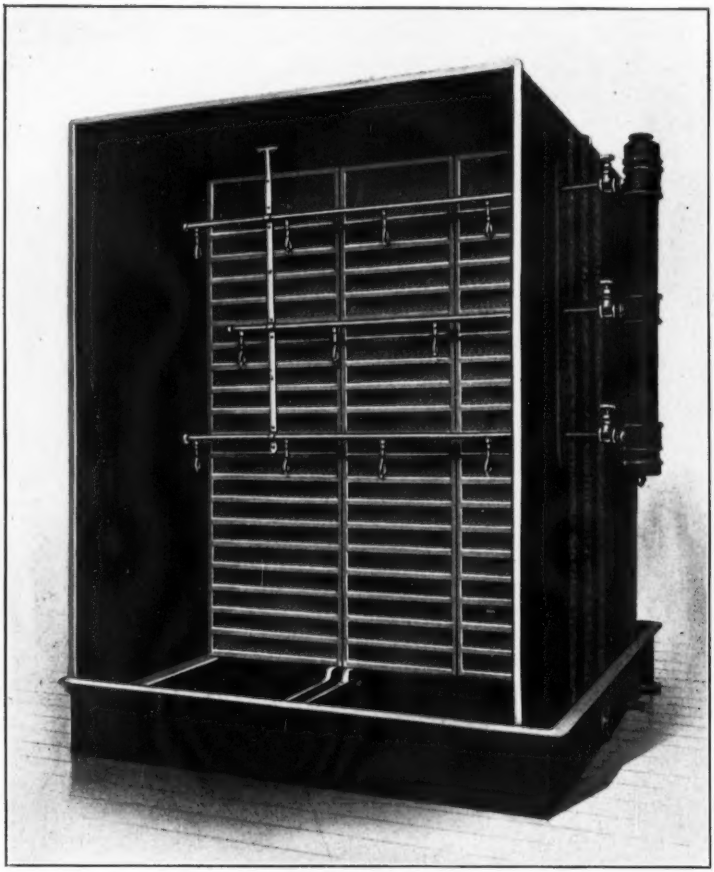
One fact frequently overlooked in the design of plants for such mills is, that the power delivered to the machinery—i. e., to the looms, knitting frames, etc.—is almost wholly transformed into heat, and it is for this reason that where a large amount of machinery is operated no extra heat is required, except for the early morning hours before the apparatus starts. In one of these large mills, 500 to 1,000 horse power may be used on a floor, and it is quite evident from a brief consideration of the mechanical equivalent of heat that no additional heat will be needed.

Air Washing.

Even when regulation of humidity is unimportant, air washing is advisable, as bacteria collect on the dust particles and air washing removes the dust and the bacteria with it. It is important in providing for air washing that the air leaving the air washer be kept down to such a point that when delivered into the room there will be no



REINFORCED-CONCRETE AIR-WASHING PLANT, MENGEL BOX FACTORY, LOUISVILLE, KY.
McCreery Engineering Co., Detroit. The casings from air intake to washer and from washer to fans are all of cement plaster on metal lath.



THE PEERLESS AIR WASHER.
New York Blower Co., Chicago, Ill.

tendency for the deposit of moisture. It is usual to keep the temperature of the saturated air on leaving the air washer or humidifier at 20 degrees below the temperature of the air in the room. By this means, even if saturated air is delivered to the room, it will rise in temperature when mixed with the air of the room, and as its capacity for moisture increases with its temperature there will be no tendency to deposit the moisture.

As the air is usually delivered through long galvanized-iron ducts, which carry sound, the question of noise from the air washer is of importance, and for this reason the "mist" type of air washer is prob-

ably preferable to the "spray" or "rain-water" type. The use of baffle-plate eliminators to take out the entrained moisture also serves to reduce the noise; and a further precaution is to install between the air washer and the fan a flexible canvas connection. The question of noise is not, of course, of great importance in factory work.

HEATING.

The question of heating the building is intimately connected with the question of the air supply, as every cubic foot of air brought in from outdoors must be heated up to at least the temperature of the room which it is to enter.

In considering this question of air supply, two distinct factors must always be considered:

1. The amount of air required for ventilation.

2. The amount of heat to be added to warm this air, and also to provide for the losses through walls, windows, skylights, doors, etc., or the amount of heat to be abstracted to cool it.

It is evident that if a factory is used for storage purposes on two or three floors, no ventilation is required but a certain amount of heating or cooling is necessary, depending upon the contents. On the other hand, if the floor is full of operatives, or if machinery is being operated, the amount of heat required is reduced, but the amount of air required for ventilation is increased and usually becomes of paramount importance. This, however, is not the case during the night time, unless the shop operates the whole twenty-four hours, full-shift, nor is it the case during slack time, when perhaps half or two-thirds of the operatives are laid off, nor in the early morning hours when the building is being warmed up before work starts. At such times, the ventilation factor practically disappears and the sole question is one of heating. It follows from these considerations that a system designed for one particular state of affairs will be uneconomical under all the other conditions, unless provision is made for meeting the varying conditions as they arise.

If no provision is made for taking care of this "off-time" heating, except drawing air from outdoors and heating it up to the required amount to make good the losses, it is evident that for every 1,000 cubic feet of air brought in and raised to say 110 degrees, 2,000 heat units will be required, approximately equal to the condensation of 2 pounds of steam, while if this air is brought in at 70 degrees or 60 degrees only one-half the number of heat units will be required. This means that either the air must be re-circulated or provision must be made for heating the building, taking care of radiation losses through walls, windows, etc., by direct radiation surface, letting the ventilating fans

supply only the air required for ventilation, this air being heated to merely the temperature of the room.

Provision for re-circulation, while a matter of economy in operation, is a doubtful expedient, except in certain instances; because as soon as the engineer in charge or the owner finds that by re-circulating the air more or less he can reduce the expense for fuel, he will adopt this method, and poor ventilation will result. The exceptions noted are such plants as have an excess of exhaust steam available, as in this case there is no tendency on the part of the engineer or owner to reduce the ventilation because no benefit would be obtained thereby. Another case is where re-circulation can be adopted continuously—i. e., where air can be withdrawn from storage rooms or storage floors, halls, etc., passed over heating coils, and distributed to the manufacturing departments.

Where re-circulation is not advisable, direct radiation must be resorted to if economy in steam is to be obtained. Direct radiation has also the advantage of supplying the required heat when natural ventilation is used and mechanical ventilation stopped.

In a climate such as that of New York, there are, perhaps, eight months in the year when windows can safely be opened and natural ventilation obtained, provided some means is given for warming the air coming in through the windows. During October and November, and even in December, and in March, April, and May, there are many days when natural ventilation is preferable to air received through ducts and flues after being heated. The air comes in with a "live" quality through the windows, varying in velocity, and it is to be preferred, and it will be preferred, to the air received from the fan system unless the manufacturing processes require a stated humidity.

During such times, it is highly advisable that the mechanical ventilating plant be shut down and the necessary heat obtained from coils and radiators around the room. At such times, mechanical ventilation is of no use, because even if mechanical ventilation is supplying the air as it is designed to do, open windows and breezes will entirely change the distribution of this air and prevent the proper distribution of the heat.

In ordinary workshops and factories, therefore, where there are no gases, dust or vapors to be removed, it is my practice to use a combination of direct and indirect systems.

Cost of Ventilation.

Definite figures are always a better means of focusing the attention than are abstract discussions. Assuming that coal costs $3 a ton of 2,000 pounds and that there are 7,000 available heat units in each

pound of coal (by this I mean that out of the 11,000 or 12,000 heat units available in a pound of No. 1 buckwheat coal, between 7,000 and 8,000 are actually delivered into the room in the form of heat in the air, the remainder being lost through radiation in connection with the boiler setting, ducts, fans, and heaters or allowed to go to waste without doing any good), and assuming extreme conditions of zero degrees weather outdoors and an indoor temperature of 65 degrees, the cost of heating 1,000 cubic feet of air from zero degrees to the temperature of the room, when exhaust steam is not available from the steam engine, is as follows:

$$1{,}000 \times \frac{13}{55} \times 300 \text{ cents} \div 2{,}000 \text{ pounds} \div 7{,}000 \text{ heat units.}$$

The result is 1/40 cent; this is the cost of heating 1,000 cubic feet of air from zero degrees F. to 65 degrees F. This may be taken as the maximum cost of ventilation.

If the air is to be heated from zero degrees to 130 degrees, or from 10 degrees to 140 degrees, the cost is 1/20 cent. If we assume the average winter temperature to be about 32.5 degrees F., it is evident that the saving to be obtained by re-circulation of the air would be 1/80 cent per 1,000 cubic feet of air delivered—i. e., if it cost 1/40 cent to heat the air from zero degrees to 65 degrees, it would cost 1/80 cent to heat it from 32.5 degrees to 65 degrees F. Again, if 1,000 cubic feet of air will act as a carrier for 65,000 ÷ 55 B.t.u. if the air is allowed to drop from 130 degrees to 65 degrees F., or from 140 degrees to 75 degrees F., this is equivalent to 1,182 B.t.u. 1,182 B.t.u. is about the amount of radiation obtainable from 4 square feet of radiation an hour with exhaust steam at from 1 pound to 5 pounds pressure; it follows from this that for 4 square feet of direct radiation, a saving of 1/80 cent per hour is made over the cost of heating directly by a fan system drawing the air from outdoors—always provided that there is not sufficient exhaust steam to heat the coils of the fan system; and every square foot of radiating surface saves 1/320 cent per hour.

It is also true that every 1,000 cubic feet of air re-circulated, instead of being taken directly from outdoors, saves 1/80 cent.

Assume a building requiring 1,800,000 B.t.u. per hour, to make up the losses through walls, windows and other openings. This amount of heat could be either supplied by 6,000 square feet of coil radiation along the walls, or it could be supplied by a fan system taking the air from outdoors, heating it to 140 degrees and allowing it to fall to 75 degrees. The saving in such a building, allowing for starting up two

hours earlier in the morning—about 5 o'clock if the building opens at 7 o'clock and stops at 6 o'clock at night—making 13 hours of operation, would be 18 cents per hour, and the average saving per day would be $2.34. The same saving, approximately, would be made if all the air supplied, except that required for ventilation, were obtained by re-circulation.

In the case just assumed, with a maximum requirement of 1,800,000 heat units an hour, it would apparently be necessary to deliver approximately 1,500,000 cubic feet of air per hour at 140 degrees F., or 25,000 cubic feet of air per minute. A building requiring this amount of heat would be a building about 125 feet square, of five to seven stories, with the usual amount of glass and exposure. Such a building, however, might house from 200 to 300 employees or there might be only 100.

Allowing for a maximum of 300 employees, the total amount of air required per hour for ventilating purposes would be 600,000 cubic feet. This air could also be used for supplying heat and no extra loss would be involved. 600,000 cubic feet of air falling from 140 to 75 degrees would give out approximately 720,000 B.t.u. per hour. This would leave about 1,000,000 B.t.u. to be provided for by re-circulation, less 150,000 B.t.u. from the operatives and 100,000 from say 40 horse power of machinery; the amount of air to be re-circulated would be finally between 10,000 and 11,000 cubic feet per minute, and this only in severe weather.

In this connection, the following figures may be of interest, as they afford a rough means of figuring the amount of direct radiating surface required. Taking the usual conditions around New York as a basis, a requirement of 10 degrees F. as the outside temperature, and 65 degrees F. inside, with walls 12 to 16 inches thick, the number of heat units required per hour would be:

The amount of glass surface multiplied by 70 plus the amount of wall surface multiplied by 18; number of operatives multiplied by 1,500 less the number of horse power of machinery multiplied by 2,500. If no air is supplied for ventilation, allowance must be made for infiltration of air, and it is usual to figure that the air will be changed in one hour. In such case, add one heat unit per 1,000 cubic feet of contents of building to be heated. These figures result in the following formula for direct radiation:

$$\text{Sq. ft. radiating surface} = \left(K \left(\frac{G}{4} + \frac{W}{16} + \frac{M \text{ Cu. Ft.}}{300} \right) \right) - \left(\frac{5 \text{ oper} + 9 \text{ HP.}}{3} \right)$$

K is a variable quantity, varying from one to one and one-fifth, depending upon exposure—continuous or partial, time heating, etc.

These figures are based on a radiation of between 280 and 300 B.t.u. per square foot per hour from coil heating surface, placed alongside the outside walls under the windows, with the conditions of temperature noted.

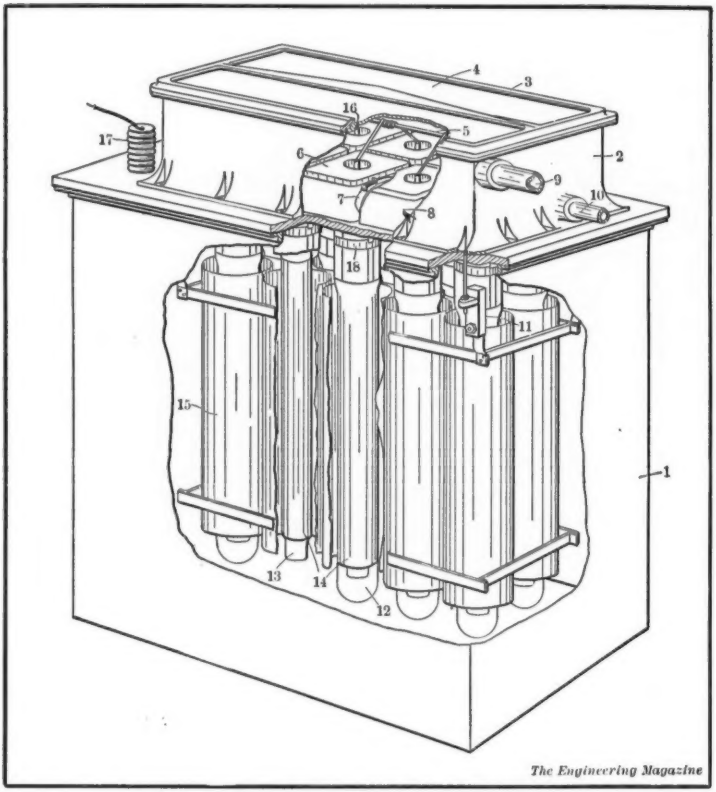
The amount of surface required for heating air supplied by the fan system is an entirely different quantity from that required for direct radiation, as the amount of condensation in a pipe or coil increases as the speed at which the air is discharged through the coils increases; because the heat is transferred from the coils to the air largely by convection—very little by radiation.

While it is true that the total rise in temperature will be greater with a greater depth of heater, it is also evident that after the air has passed over the first few rows of coils it approaches more nearly the temperature of the steam in the coils, and hence the rate of transmission is very much less and the added surface is nothing like of proportionate value. This is one reason why it does not pay to run the temperature of the air, for heating purposes, up above 135 or 140 degrees, as in order to obtain a higher temperature it becomes necessary to make the heater very much deeper and the cost of installation increases at a greater proportion than the results warrant.

If the steam in the coils is at a temperature of 220 degrees and the incoming air is taken at an average of 30 degrees, there is a difference of 190 degrees between the surface of the first sections and the incoming air, while at the end of the heater, where the air leaves, there is a difference only of between 70 and 80 degrees—i. e., between 220 and 140 or 150 degrees. Hence, the amount of heat transmitted in the first sections of the heater should average twice the transmission in the latter end.

A matter of importance in connection with any ventilating system is the character of the air delivered into the system. Out in the country, in a factory plant, where the air is clean and not befouled with smoke or other fumes, the air supply for the ventilating system may be taken wherever it can most conveniently be obtained; but where this is not the case, where the work-shop or factory is located in the city, or where the processes involved befoul the air around the factory, there are several points to be considered.

The first is the location of the intake in the cleanest possible position; and if it is not possible to obtain clean, fresh air by the location of the intake, then it becomes necessary to provide some means for the cleaning of the air. The delivery of dirty air is not only bad from



PERSPECTIVE VIEW OF GERARD TEN-TUBE OZONATOR.

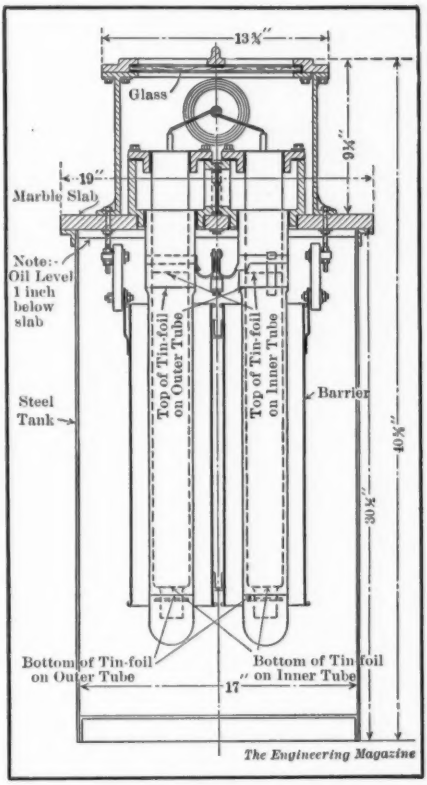
1, steel tank; 2, aluminium casing; 3, casing cover; 4, glass; 5, upper bus bar; 6, inner tube holder; 7, tightening band; 8, outer tube holder; 9, dry-air inlet; 10, ozone outlet; 11, barrier insulator; 12, outer tube; 13, inner tube; 14, tinfoil; 15, barrier; 16, glass holder; 17, insulator; 18, outer tube contact.

a sanitary point of view, but in a great many processes of manufacture the delivery of dusty air causes a marked deterioration in the quality of the product, and in fact the result may be so injurious as to make the operation of the ventilating system impossible.

The location of the intake has a bearing on the economy of operation. If the air supply is to be used for heating, or if it is to be used mainly in cold weather, it is advisable to locate the air supply on the warm side of the building. On the other hand, if the ventilating supply is intended to cool the room, as an engine room, the intake should

be located on the cool side of the building—i.e., in this climate, on the north or east side; the warm side being the south or west.

The size of intake will also have a bearing on the freedom of the air from dust. If the size is restricted so that the velocity is excessive—i. e., above 800 feet per minute—there is a greater tendency for the drawing in of dust than there is if the velocity is kept low—say, 500 feet per minute. The method of cleaning the air has been discussed, but whatever method is adopted, provision must be made for the screening and removal of the dirt taken out of the air, otherwise the so-called cleaning apparatus becomes a menace to health and detriment to the operation of the ventilating plant.



CROSS SECTION OF GERARD OZONIZER SHOWING ASSEMBLY OF PARTS.

Insofar as the exhaust outlet is concerned, the main points to be observed are that the outlet should be placed away from the inlet and away from windows, and it should also be provided with a hood so designed that wind pressure will facilitate the exit of the air rather than retard it.

A discussion of the heating and ventilating of factory buildings would not be complete without some reference to the subject of ozonization. Practice is still in process of development, and although the use of ozone as a purifying agent has become more or less general in Europe it has only been tried experimentally in the United States and with no very definite results. The most notable

American instance is the installation in the Chicago Public Library Building, and while the offensive odor seems to have been removed from the air the authorities are not yet prepared to make a definite statement as to the advisability of installing a complete ozonizing apparatus.

A letter from the Hoftheater, Stuttgart, herewith presented in translation, speaks very well for the results obtained in that installation, and it would seem to me probable that ozone could be employed to advantage in confined spaces where ventilation by the introduction of fresh air and the removal of foul air was not readily possible:

(*Translation*)

Replying to your letter of the 7th instant, we have honor to inform you as follows:—

The ozone apparatus of the Elworthy-Koelle system installed by us in the year 1906 has proved very good in every way. The unfavorable conditions in the local Hoftheater did not formerly permit of successful ventilation of the auditorium during performances. Since the ozone apparatus has been in service there is no longer impure air in the auditorium, and the temperature is not unbearable even with the house full. Flying dust settles on the ground in consequence of the cool ozone, and the scenes on the stage stand out more clearly in consequence thereof.

The apparatus which is connected to the electric circuit, and which consumes current to the amount of only 20 horse power per evening, permits of the distribution of the ozone (generated by electricity) to the remotest parts of the theatre.

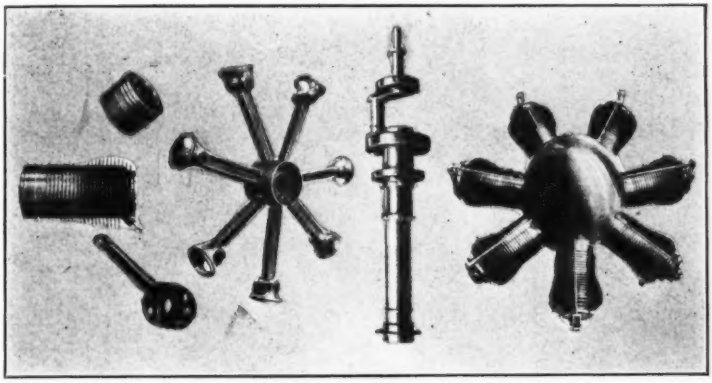
It is installed in the ventilating chamber; thence, the ozone passes through air ducts into the auditorium. Furthermore, a special tube system with two branches runs into the orchestra pit and to the supers' room.

The air improved by the ozone has the normal amount of humidity. The effect of ozonization of the air is a double one: On the one hand, it stimulates the audience, which is made uncomfortable by unhealthful substances and germs exhaled by the crowd of people, and on the other, produces a favorable effect upon the vocal wellbeing of the singers and upon the physical condition of the orchestra.

Very respectfully,

(Signed) BARON PULLIN.

The process of ozonizing air is essentially the same in the different systems, and consists of forcing air through tubes through which an electric discharge takes place, the electric discharge changing the particles of O_2 to particles of O_3. This extra atom of oxygen is only temporarily attached, and at the earliest opportunity it will combine with any carbonacous material, performing a chemical combination which amounts to the same thing as burning up the organic matter present in the air.

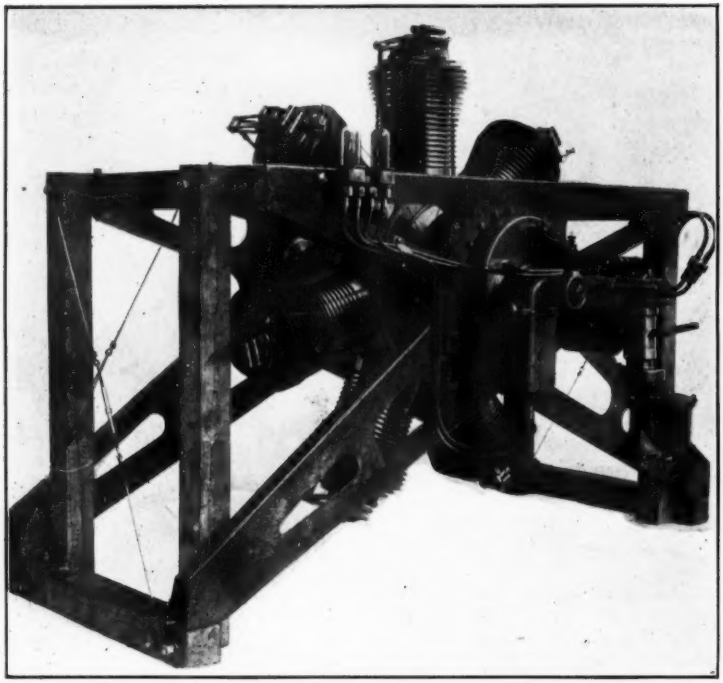


GNOME MOTOR; AVIATION HOOD AND INTERIOR PARTS.

FRENCH AEROPLANE MOTORS.

By Warren H. Miller.

SO long as the weight of gasoline motors remained at about 20 pounds per horse power there was little hope of doing anything in the way of practical results with the development of aeroplanes. Even in the very smallest plane the presence of the element of skilful, trained *human* control is absolutely necessary; therefore the dead weight of the motor and aeroplane, plus the live weight of the pilot, would be the least that could be considered. For this reason the nicest and best calculated designs of the earlier men, who had to use steam for motive power, always failed. They either were so heavy that a man could not be carried besides the motor, or else they used up far more steam than any boiler could generate in the required time, so that the flight exhausted all the reserve steam in a few minutes. It was to the development of the automobile industry that the light motor that made aviation possible is due, running now as light as two pounds per horse power. That by the Société Gnôme is 3.36 pounds per horse power, is much used, and holds two of the

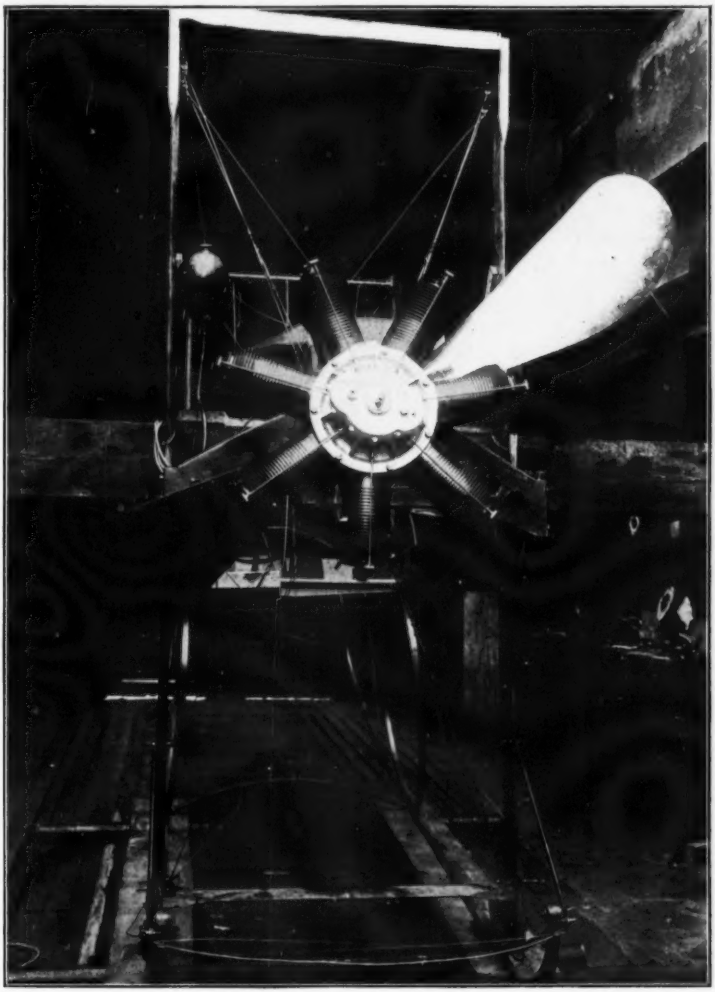


PRESSED-STEEL MOUNTING FOR GNOME MOTOR, FARMAN AND SOMMER BIPLANES.

world's records—that by Paulhan at Los Angeles for height of 1,520 meters, and that by H. Farman of 232.2 kilometres in 4 hours 17 minutes 53 seconds for distance and duration, so it will be well to begin the list with it.

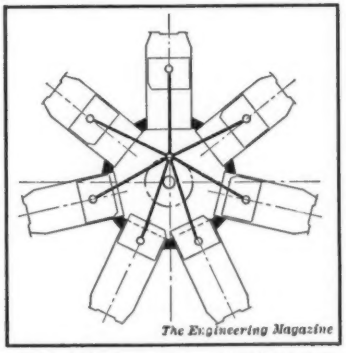
As will be seen by the cut, it has seven cylinders, which form the flywheel as they rotate about the crank, which is fixed. The one idea of this motor has been to obtain lightness by the design and not by the materials. There is no aluminium anywhere in it, nor any cast pieces. The cylinders are machined complete, vanes and all, out of solid blocks of forged steel, and all the reciprocating parts are of nickel-steel. The body is of tool steel, and the cylinders are secured to it by segmental rings locking in the annular rings cut on the cylinders, and held in place with keys. Thus any cylinder can be taken off instantly. The general working of the motor, which is four-cycle, is apparent at a glance at the line-section on page 884. Page 881 shows

details of the crank, pistons, valves, and connecting rods. The master-bearing, to which all the connecting rods are attached, has two sets of ball-bearings on the crank, and the inlet valve seats form also the housing for the connecting-rod pins. The inlet valves are counter-weighted against the centrifugal force of the rotation by small lever



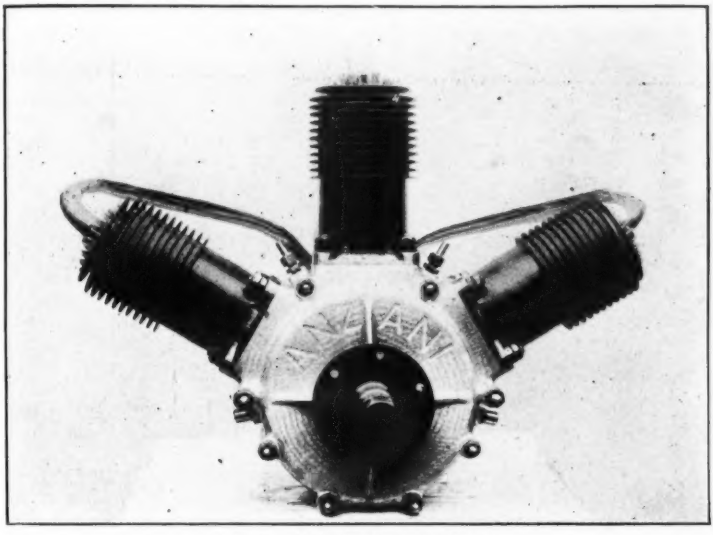
FACTORY TEST OF GNOME MOTOR ON THE CHASSIS OF A BIPLANE.

counterweights, so that they open properly for admission. The escape valves are in the tops of the cylinders, opening inwards by rolling cams, connected by their rods to the trip-movement in the main bearing case. The exhaust simply escapes into the air. Cooling is entirely by the vanes machined out of the cylinder forgings, which, of course, rotate at great velocity. The motor is attached directly to the propeller, and the flywheel effect of it has proved of great value in aviation, as many other motors, which depend on the screw and 90-degree cranks for uniform rotation, have had unaccountable breaks in the screw while under way, making it necessary to glide back to earth without power. The gasoline is mixed by a float-feed automatic air inlet carburettor, and fed into the crank case through the shaft, which is hollow, and the oil is pumped in by a rotary force pump through the same channel. Once inside, it is carried by the centrifugal force through ducts to every moving part of the cylinders. The spark-plugs project some distance into the interior of the cylinder, and are thus protected from the oil, which collects on the ends of the cylinders and passes out with the exhaust. Ignition is by magneto, with seven-point timer. This motor is made in three sizes, 30, 50 and 100 horse power, of 5, 7, and 14 cylinders respectively. The 30-horse, for light monoplanes, is 4 inches bore by 4 inches stroke, 1,300 revolutions per minute, 132 pounds weight. The 50 horse power is 4½ inches by 5 inches approximately, 1,200 revolutions per minute, 168 pounds weight. The 100 horse-power has the same bore and stroke, twice the number of cylinders, same revolutions, and weighs 220 pounds.



THE GNOME MOTOR. DIAGRAMMATIC SECTION.

The next motor to notice would undoubtedly be the Anzani, the one which flew across the Channel with Blériot in *Blériot XI.* This is made in four sizes, 15, 30, 40 and 50 horse power, all of three cylinders, arranged as on page 885. The cooling is by the circular vanes, cast integrally with the cylinders, in steel. Inside the case are two flywheel plates forming the faces of the crank, one of which is cammed, to act on the valve rods of the exhaust, thus cutting out the necessity of valve shaft and its gears. The admission valves are in the cylinder-heads, supplied by a three-branch pipe

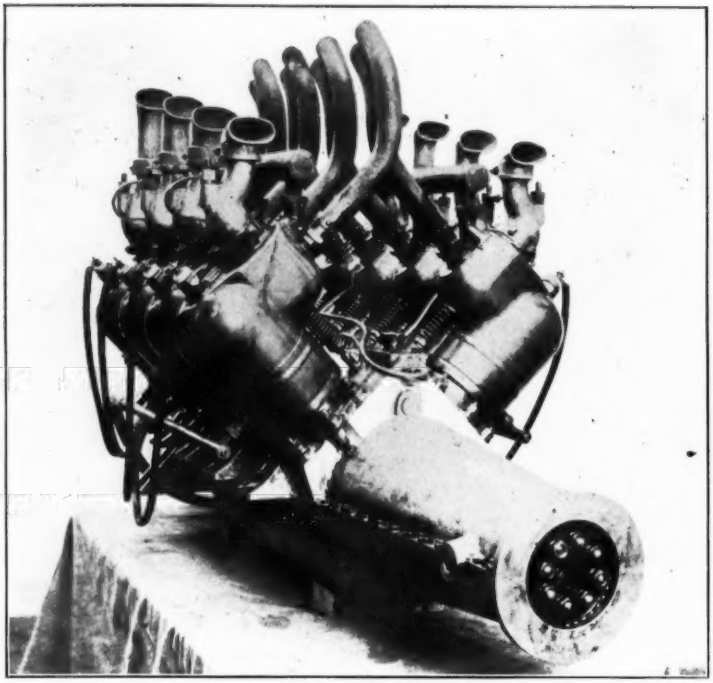


ANZANI 50 HORSE-POWER MOTOR.

from an ordinary carburettor, and the valves themselves are automatic spring poppets. The four sizes, of which No. 2 crossed the Channel with Blériot, are: 15 horse power, 3⅜ inches by 4 inches, 1,800 revolutions per minute, 3 cylinders, 84 pounds weight; 30 horse power, 4¼ inches by 5¼ inches, 1,600 revolutions per minute, 3 cylinders, 145 pounds weight; 40 horse power, 4¾ inches by 5¼ inches, 1,500 revolutions per minute, 3 cylinders, 172 pounds weight; 50 horse power, 5⅜ inches by 6 inches, 1,400 revolutions per minute, 230 pounds weight.

Specification:—Cylinders special cast-iron, in one piece with valve chambers and air-cooling vanes. Valves 5 per cent nickel steel. Pistons grooved, extra-light, machined hollow. Cranks forged steel. Axles of flywheel-crankshaft of refined nickel-steel, sweated and cemented into the flywheels. Flywheels in cast steel. Distribution without cam-shaft, by pinions engaging cams. Splash-oiling with ducts to all wearing parts. Automatic carburettor, without throttling gear. Ignition by 6-volt storage battery, or magneto. With it in *Blériot IX*, Blériot made the first cross-country run, stopping twice to adjust his apparatus, and flying altogether about 40 kilometres.

In *Antoinette IV*, Latham made his flights across the Channel, almost reaching Dover in the last of them, and, in *Antoi-*



ANTOINETTE 40 HORSE-POWER MOTOR.

nette V, he made the French record of duration with the same motor. Later, H. Farman won the Grand Prix for distance and the world record for duration using an Antoinette 40 horse power in one of his aeroplanes. Later these records were all eclipsed by others, but during the last few months the Antoinettes have shown up splendidly in the various meetings in Europe. The motor is eight-cylinder, four on a side, arranged in a V of 90 degrees, each pair working on the same crank. With four cranks, there are always two cylinders doing work so the rotation is very uniform and the propeller answers for a flywheel. The cylinders and valve boxes are machined out of a single piece of steel so that the whole chamber of explosion is an integral piece, and the cooling jacket is of red copper, formed in one piece by electrolysis. This motor must of necessity have a separate radiator, as there is little opportunity to get at the interior cylinders with currents of air, so it is made of slender tubes arranged to form

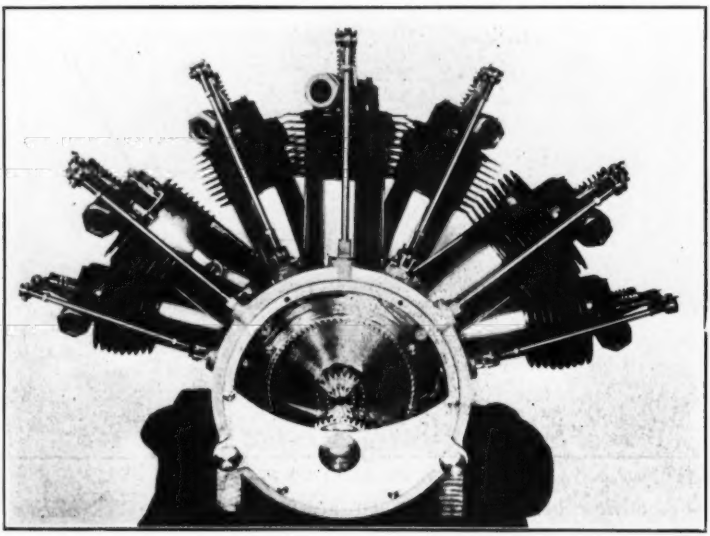
a plate about 2 feet high by 9 feet long and ½ inch thick. This only weighs 24 pounds, for 14 square yards of surface. There is no carburettor, but the mixture is forced into the cylinders by a pump. This motor is made in two sizes, 50 and 100 horse power, the only difference between them being that one has eight cylinders and the other sixteen. The bores are 4⅜ inches, stroke 4¼ inches, revolutions per minute 1,200, weights 192 and 330 pounds each.

E. N. V. MOTOR, 40 HORSE-POWER.

Another motor of very similar arrangement is the "E. N. V." made in 40 and 60 horse power. Blériot has one on his latest design, the *Blériot XII,* with one of which he made the sensational flights with a passenger at Rheims. In this motor the carburettor is used, and the exhausts are all separate at the top of each cylinder. It also has a water radiator. It further differs from the Antoinette in having both inlet and outlet valves mechanically operated by the lay-shaft, which is inside the case. It is made in two sizes, 40 and 60 horse power, the former 3⅜ inches bore by 3½ inches stroke, 1,500 revolutions per minute, 154 pounds weight; the latter 4¼ inches by 4⅜ inches, 286 pounds weight. Both motors have eight cylinders.

Among those of the ordinary type, with four to eight cylinders mounted in a row vertically above the crank case, that of the Clément-Bayard Company may be mentioned. The crank case in these is of aluminium, the cylinders cast in semi-steel and the cooling jackets in

red copper. This motor is used in the *Demoiselle* type of Santos Dumont, the lightest, smallest, and fastest monoplanes in the world. They are furnished in two, four and six cylinders, in 20, 40, 100, and 200 horse-power sizes. The 20's and 40's are 4 inches by 4¾ inches, 1,500 turns, distribution by a lay-shaft inside the case actuating both inlet and outlet valves, cooling by a radiator and centrifugal pump, and oiling by drip-feed, forced by a pump in the crank case. The carburettor is constant level, arranged to operate at all angles, ignition by spark plugs. The weight of the 40 horse power is 242 pounds.

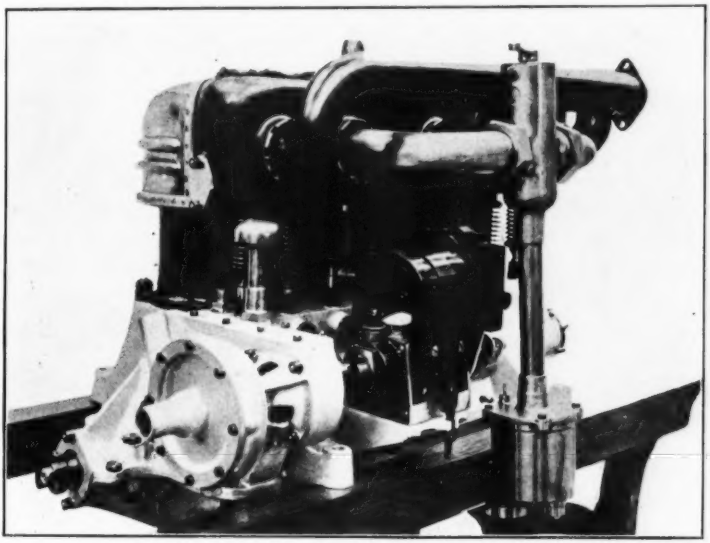


R. E. P. 60 HORSE-POWER MOTOR.

These motors have thus far roughly divided themselves into two groups, one cooling by air-vanes and the other by radiators. Still a third group is that in which the cooling is effected by ventilator fans, blowing on the cylinder-vanes, the fan at the same time acting as a flywheel. Of this class the most famous representative is the "R. E. P." constructed by M. Esnault-Pelterie, the president of the French Association of Aerial Locomotion, and inventor also of the R. E. P. Monoplane. It was with this motor that Maurice Farman obtained the world's record of the *Vol de Buc á Chartes*. It is on the market in three sizes, 20, 30, and 40 horse power, of five, seven, and ten cylinders respectively, all of 3⅜ inches bore by 3¾ inches stroke, and revolutions per minute maximum of 1,500. The weights are 82, 115, and 158 pounds respectively. The extreme lightness of these

motors is obtained by careful design, and the selection of the strongest possible materials of construction. The cylinders are arranged in radial fans, of 3 and 4 cylinders, side by side, "staggered," acting on two cranks at 180 degrees. By this arrangement, there are always two cylinders working per revolution, or one impulse per stroke, giving very uniform turning moment. The exhaust and intake is managed for each cylinder by a single valve, which takes two positions under the action of the lay-shaft, connecting either the exhaust ports to the air, or the intake to the mixture pipes.

The matter of propellers is so intimately bound up with the engines themselves that some mention of those in use for aeroplanes seems almost essential in a description of types of motors. The first aerial screw was proposed and used by Leonardo da Vinci, the great artist, architect and man of learning of Italy, who, like Giotto and



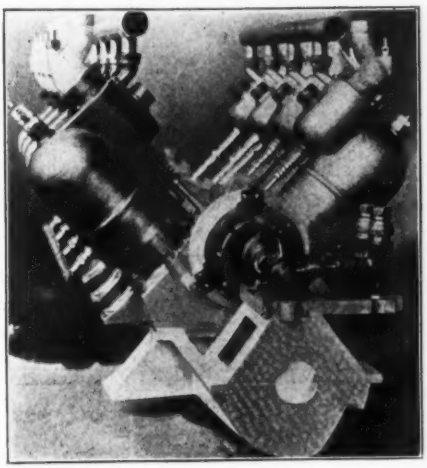
CLEMENT-BAYARD 40 HORSE-POWER FOUR-CYLINDER MOTOR.

Michael Angelo, was too big for any one art to contain. After the fashion of most master-minds, he went right to the heart of the matter and pointed out the ideal screw propeller for air navigation, but it was centuries after before the little men around him could get away from the follies of oars, paddlewheels, windmills, and such primitive ideas that encumbered their minds, and it was not till 1834 that a series of Frenchmen finally developed the screw for balloon propulsion; fifty years thereafter, it approached the true helix under Dupuy de Lome,

in 1872. Colonel Renard in 1888 published the results of his numerous experiments on the losses due to slip, etc., and the causes thereof, and gradually it became apparent that these should not exceed 30 per cent of the work of the motor in any well-designed screw. The development of the various types soon again evolved two classes—slow-speed and large diameter, and high speed with small diameter. At present both classes have their ardent adherents, but, in view of the conclusive results in favor of the slow speeds and large diameter, obtained by experiments with ordinary blast fans during the last few years, there is no doubt that the best results are gotten by the slow speed and reasonable diameter of propellers. The French never use two propellers, as in some American makes, principally because of the great danger that ensues when one of the screws breaks or stops, if there are two. They all vary in size between two and three metres, and 600 to 1,200 revolutions per minute. Specifically, the Voisin is 2.3 metres, 1,100 revolutions per minute; Clément-Bayard, 2.4 metres, 750 revolutions; Blériot XII, 2.7 metres, 580 revolutions; Farman, 2.5 metres, 800 revolutions. The principal problem at present is to get a strong, light material, which will not warp in the weather, will not fly to pieces under the centrifugal force, nor bend out of shape, and yet be light and shapely. You can buy them from the various aeroplane dealers in Paris, in solid wood; hickory and ash, glued up of sections of flat pieces; in black walnut, oak *fumée*, hickory and holly; or you can get them in solid cast aluminium finely finished, prices varying from $100 to $150 each. I think that when Americans get around to it, we will stamp them out of sheet steel in two pieces, and clinch-lock the edges.

A *résumé* of the aeroplane motors is appended below in the concise form of a table of comparative costs and weights per horse power based on the 50 horse-power size. It will be noticed that the Clément-Bayard is by far the heaviest, in spite of using aluminium for the case, thus adding to the already large mountain of proof that for equal strength steel is always lighter than aluminium. The table also brings out the increased cost necessitated by multiplication of cylinders, to obtain increased horse powers at light weights. The Anzani, with only three cylinders, is by far the cheapest, but its weight is about midway between the Clément and the Gnôme, the lightest of them all. Just why nothing has been done in the line of cylinders larger than 4½ inches by 5 inches, say four large cylinders in a cross, revolving about a central case, *á la* Gnôme, has not yet been satisfactorily answered by the French constructors. Possibly our own may

show them a thing or two in this matter,—when they get going. The French are considerably exercised (aside from the patent disputes) over the size of the Wright motor, compared to their own. This is only 25 horse power, for an aeroplane weighing 470 kilogrammes, or about the same as most of the French, yet they always need a 50 horse-power motor, and so have to carry a good deal more gasoline to make the same records of duration and speed as the Americans. It cannot be explained by the difference in estimating "horse power," as the Wright motor is 4⅛ inches bore by 4 inches stroke, weighing 7.2 pounds per horse power, thus being the heaviest of them all. It is four-cylinder, and therefore only half the power of the eight-cylinder French motors of the same bore and stroke. They have finally ascribed the difference in horse power required to a combination of better propellers, absence of "feathering" and less skin-resistance of the Wright bi-plane, yet, as their aeroplanes are far steadier and better poised than the Wrights exhibited in France, precisely because they all have feathering and rear supporting planes at the end of equilibrium tails, they prefer to lose the horse power in return for greater steadiness.



THE ANTOINETTE MOTOR.

TABLE OF FRENCH AVIATION MOTORS.

Make—	H. P.	Weight per h. p.	Cost per h. p.	Speed.
Antoinette	50	3.84lb	$48.00	1,200
Anzani	50	4.6 lb	20.00	1,400
Gnôme	50	3.36lb	52.00	1,200
E. N. V.	40	3.85lb	37.50	1,500
Clément-Bayard	40	6.05lb	47.50	1,500
R. E. P.	40	3.96lb	70.00	1,500
Wright	25	7.2 lb	——	1,400

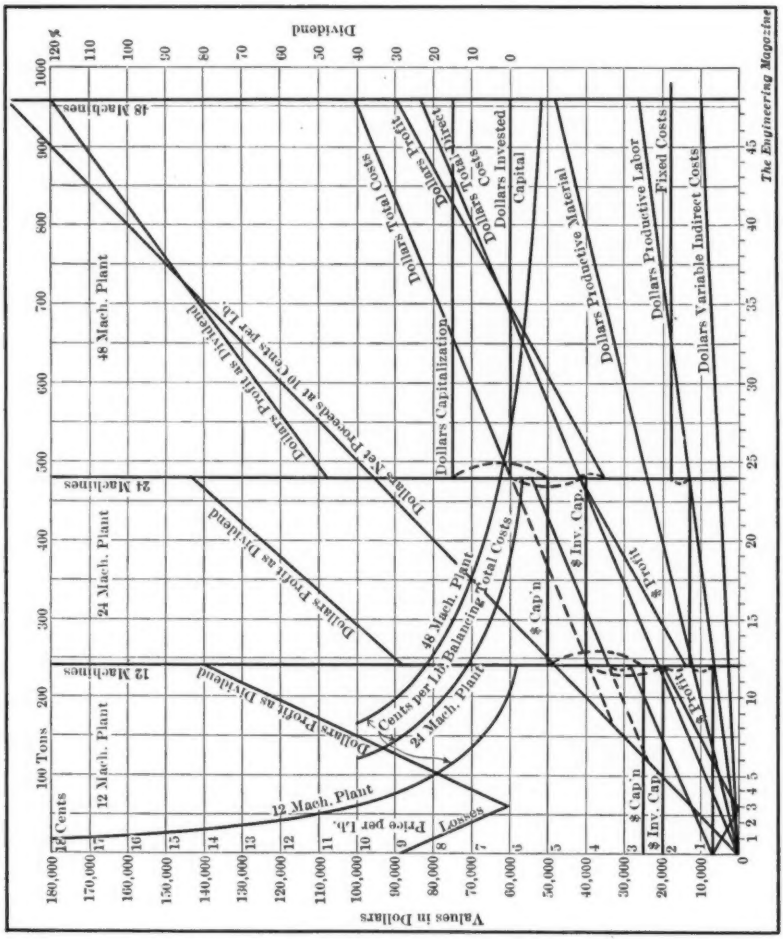


CHART OF MANUFACTURING PROFITS AND LOSSES AT VARIOUS RATIOS OF OUTPUT TO CAPACITY.

This chart is discussed in Mr. Hess's article following.

MANUFACTURING PROFITS AND LOSSES.

A STUDY OF RELATIONSHIP BETWEEN CAPITALIZATION, INVESTED CAPITAL, LABOR, MATERIAL, OUTPUT, AND SIZE OF PLANT.

By Henry Hess.

Last year the author gave a series of lectures before the graduating engineering class of Columbia University on matters connected with the building and operation of a manufacturing plant with a view to its final object of existence from the owners' or investors' standpoint—the payment of dividends. The Editors of THE ENGINEERING MAGAZINE have asked the author to explain his analysis in the following article. The method outlined has been found very useful by the author in his own actual practice and business, with various modifications, to elucidate various phases and changes in conditions. The basic principles and methods are applicable to business of any nature whatsoever, be that manufacturing, merchandising, engineering, architecture, etc., so long as costs are incurred and something sold, be that a tangible object, set of plans, or even advice.—THE EDITORS.

EVERY manufacturer, every business man and every professional man—every one intending to join their ranks—is of course more or less fully aware that in order to realize the final end for which the risks of business are undertaken—Profit—a careful comparison and following up of all elements of cost is absolutely essential.

But the commercial agencies report a fairly large percentage of failures. Many of these are due to such adverse circumstances as heavy losses through failure of related houses, panic times, etc. Still, by far the greater cause of trouble is failure to realize the relationship of the various cost factors to size of plant, to cost, etc., and, more important still, failure to realize a tendency toward a dangerous condition in time to apply the proper remedy. Too many awake too late from the notion that the keeping of a correct set of books, or even of an elaborate cost-keeping system, is all that is needed. These do contain all the elements, but merely as an array of figures, the relationship and interdependence of which and, more particularly, the trend of which, it is given to but few to grasp quickly and readily.

The difficulty of such oversight is resolved by resort to a diagrammatic presentation. As an example, assume a plant that is building a special machine (values cited herein are, naturally, only assumed to serve in illustration).

Following the usual practice, cost of product will be divided up

into "Productive Labor," "Productive Material," "Variable Indirect Costs," and "Fixed Costs."

To Productive Labor are charged all items of cost of material directly embodied in the product sold.

To Variable Indirect Costs are charged all items that are directly proportional to the size of the output.

To Fixed Costs are charged all items that are less directly related to the size of output; such as foremen, office force, depreciation, interest, taxes, etc.

Variable Indirect Costs and Fixed Costs together make up what is usually termed "Burden," "Overhead Charges," etc. The division makes possible a closer analysis and recognition of the changes in cost due to an increase in output. To illustrate:

A plant will have to be provided even before a single machine is built. The consequent charges for taxes, interest, depreciation, are incurred whether ten machines or none at all are built. Such charges are Fixed Costs. On the other hand, fuel charges for power, oil, waste, material not entering directly into the machines, and similar items, will be zero when no machines are built; they increase in direct ratio with increase in output. Such charges are therefore Variable Indirect Costs.

In the diagram the vertical scale represents values in dollars and the horizontal scale size of output. At the base, size of output has been given in numbers of machines built; at the top the corresponding weight in tons is given as the scale.

Increase in output carries with it a proportional increase in Variable Indirect Costs, Productive Labor, and Productive Material. The lines representing these in the diagram will therefore all start from zero for zero output.

Increase in output does not immediately carry with it an increase in the Fixed Costs. On the contrary, these remain fixed over a range of output. In the case here illustrated $7,000 takes care of an output up to twelve machines (240 tons); this jumps to $13,000 from twelve to twenty-four machines (480 tons); a further increase to $18,000 will carry from twenty-four to forty-eight machines (960 tons). This is shown in the diagram by a series of horizontal lines labeled "Fixed Costs."

Summing up all of these cost items gives Total Costs, shown in the diagram by slant lines, so labeled; the break occurring at twelve and again at twenty-four machines is due to the increase in Fixed

Costs attending enlargement of plant, of supervising force, etc., at each such increase of output.

The output is considered as sold at a uniform price of 10 cents per pound. This is represented in the diagram by the slant line starting at zero labeled "Net Proceeds."

The difference between Net Proceeds and Total Costs is "Profit," if the Net Proceeds is the larger item. These profits are shown in the diagram by the slant lines so labeled. The break in these is due, as before, to the change in Fixed Costs occurring at twelve and twenty-four machines.

The profit line for twelve machines and less intersects the base at three machines. This indicates that the profit is zero at three machines. The continuation of this line is shown as a reversed slant. When no machines are built the consequent loss must equal the Fixed Costs for zero output; the reverse slant line therefore intersects the vertical scale at $7,000. It shows also that when only one machine is built the loss is slightly under $5,000. The Total Cost line for zero to twelve machines crosses the Net Proceeds line at three machines, indicating that, unless the plant can be employed at over 3/12 or 25 per cent capacity, its operation will result in no profit, or even in loss if the employment be less. The larger the plant the greater the number of machines that must be turned out to barely balance the cost. In the diagram this point is found at the intersection of the Net Proceeds line with the prolongation (dotted) of the Total Cost lines. For a twelve-to-twenty-four-machine plant this point it at six machines. For a twenty-four-to-forty-eight-machine plant this point is at eight machines.

It is very important to know at what lowest price competition can be met and yet realize a profit. As output of a given kind may generally be reduced to cost and price on the per pound basis, which basis is in fact frequently used as giving a convenient factor, that is here used for analysis and pictured in the diagram by the curves marked "Cents per pound" balancing "Total Costs."

For convenience sake the lines of change, or of plant increase, are marked by heavy verticals labeled "Twelve Machines," "Twenty-four Machines" and "Forty-eight Machines."

Taking the zero-to-twelve-machine plant section at the left end and following the curve to the vertical from three machines shows that the Total Costs are balanced by a price of 10 cents per pound. This must of course be so since the Net Proceeds at 10 cents per

pound just balance (intersect) the Total Costs at three-machines output. Tracing upward from two machines to intersection with the curve shows that the costs are balanced at 12½ cents per pound; in other words, if only two machines are turned out these must be sold at 12½ cents per pound to avoid loss, and at more than 12½ cents to secure a profit.

Should competition be heavy, or should it be considered advisable to employ the plant up to its capacity, even though to do it should necessitate selling at less than 10 cents per pound, then again reference to the curve will supply the needed information. By building ten machines, 10/12 or about 83.3 per cent of full capacity, the net price may be reduced to 6.1 cents per pound to just balance costs; at full capacity (twelve machines) the costs would be balanced by a net price of 5.8 cents per pound. The twenty-four-machine plant turning out only twelve machines would have to realize net 7.1 cents per pound to balance costs (as found by the intersection of the second curve with the twelve-machine vertical at 7.1 cents). As the similar base price for twelve machines turned out by the smaller twelve-machine plant was only 5.8 cents per pound, a difference of 1.3 cents per pound, the importance of considering wisely and carefully the advisability of enlarging a plant is clear. Similarly the diagram shows that the same twelve machines when turned out by a plant capable of forty-eight machines, must be sold for at least 8.2 cents per pound or 2.4 cents per pound more than for the small twelve-machine plant. As this difference of 2.4 cents represents $2.4 \div 5.8 \times 100 = 41$ *plus* per cent of the cost of 5.8 cents, this emphasizes the point made. A matter of 41 per cent in the base sales price that just balances cost is a most serious handicap. In times of adversity, when prices are cut to the last notch, when the forty-eight-machine plant turning out only twelve machines sells these at absolute cost to avoid a shut down, the twelve-machine plant competitor, selling at the same actual price, yet realizes a profit of 2.4 cents per pound. By cutting the price to 7.1 cents per pound, or 1.1 cents below the cost of its larger competitor, the small plant is still able to realize a profit of 1.3 cents per pound.

To run a plant it is necessary to invest capital. Could that be turned over directly, in other words could the investment be realized on at the same moment that costs are incurred so that it would be unnecessary either to give or ask credit, then the investment would equal the Total Costs. A concern having a reasonable credit with its banks need not actually invest quite as much capital as will equal the

total cost at maximum output. The proportion varies greatly with conditions of the money market, cash stringency, etc. In this case a capital invested of $20,000 has been considered for the twelve-machine plant. This is noted in the diagram by the horizontal line labelled "$ Inv. Cap." which rises to $40,000 for the twenty-four-machine plant and $60,000 for the forty-eight-machine plant. Intersections with the Total Costs lines show that in the three plants Invested Capital equals Total Costs at outputs of seven and one-half, fifteen and one-half, and twenty-four machines.

If no water is injected, no charge made on account of patents, good will, etc., then Invested Capital will agree in amount with the capitalization. Usually, however, the capitalization represents a larger sum than the actually invested capital. Occasionally, a business is found in which, through the investments of profits in the plant, the actual investment is larger than the capitalization. That is relatively rare in these days of the prevalence of stock corporations; practice rules to increase nominal capital to a point that will show a relatively small dividend.

In this example a capitalization larger than the invested capital is employed, the amounts being $25,000 for the twelve-machine plant, $50,000 for the twenty-four-machine plant, and $75,000 for the forty-eight-machine plant. These are indicated by the horizontal lines labeled "Capitalization."

It follows that to the stockholder, the matter of real and final interest is the profit expressed as a dividend on the capitalization. In the diagram this is shown by the slant lines labeled "Profit as Dividend;" the dividend scale is given at the right hand. As in the twelve-machine plant the Total Costs were balanced by the Net Proceeds at 10 cents per pound, when turning out three machines, it follows that dividends are zero at that output; below that output, there not only can be no Dividend, but there must be a loss. This is shown by the reversal of the "Profit as Dividend" line, labeled "Losses." At full output the dividend line intersects the twelve-machine vertical at 80 per cent. The Profit as Dividend line of the twelve-to-twenty-four-machine plant shows that when this larger plant turns out only twelve machines its larger apparatus and investment cuts the dividend down from the 80 per cent of the smaller plant to as little as 28 per cent for the intermediate plant. When this plant operates under its full capacity of twenty-four machines it realizes from Profit as Dividend 83 per cent. Enlarging to forty-eight machines gives, at full output, a Profit as Dividend of 120 per cent.

It is evidently worth while to make the necessary investments to run the largest of the three plants as the dividend is so largely increased by the operation of the various incidental economies possible. The shadow side of the larger plant has been previously shown as residing in the fact that the smaller plant, operated at its full capacity for an output representing but a small part of the capacity of its larger competitor, realizes a profit while the latter is incurring an actual loss. The wise manager will increase whenever he becomes reasonably convinced that a larger output can be sold for a considerable number of years; but he will be exceedingly chary of enlargement under the influence of a boom. The *business* may weather the difficulties when the boom collapses, generally by the aid of outside capital; whether the *original ownership* manages to retain the *control* of the business it has built up is far more problematical. To such original owners there can be but little satisfaction in the contemplation of the enlarged plant when this enlargement has caused it to pass from their control, and when refusal to enlarge would have retained it.

EDITORIAL COMMENT

Problems of Achievement.

A CORRESPONDENT whose opinion and criticism are worthy of much respect writes with earnestness his exceptions to an editorial in our August issue, entitled "Accident and Conquest," which formulated certain views as to probable limitation of achievement in aerial navigation—or at least as to the "conquest of the air" by the media now in use.

The editorial, he says, "most curiously resembles some I seem to remember having read, cavilling at the possibilities of what are now commonplaces of existence. Really, now, did you not write this for a joke: 'There is not now, as a treasury to draw from, such an enormous margin of mechanical knowledge as lay ahead of the inventor of the steam engine'? Why, we have hardly yet begun to see even the mere edge of the 'mysteries of the Kingdom of God.'

"The mail rider on horseback outdistances the foot messenger; the mail service by train outdistances the mail rider; the telegraph and telephone vastly outdistance the train, taking in each case the type of the highest development. The automobile and locomotive have outdistanced the horse at his best. It may be possible that the aeroplane will outdistance both of them.

"My idea simply is that there are possibilities in mechanics undeveloped which are now entirely beyond our ken, and to which our present developments will in future seem like the ox-team or the snail. The minute that we allow ourselves to think that we have arrived at the apotheosis of anything except individual types, such as the locomotive, or the automobile, or the horse, do we not interpose a mental obstacle to further progress?"

The sentence quoted by our critic, and the whole argument of the editorial from which it is taken, must of course be understood as limited to the problem at issue. We have perhaps as much faith as our querist in eternal progress, but not always in the same sense. In physical geography, for instance, we can not expect to continue indefinitely the curve of knowledge begun by the Phœnicians or Marco Polo. We shall go forward in knowledge of another kind, on a curve of different equation. Granting that the mysteries of the Kingdom of God are infinite, man's capacity for acquiring and utilizing physical science is finite, and if we have come any distance at all since the dawn of mechanics, our unrealized margin of achievement is by no means much reduced. The marine engine of 1825 used 10 pounds of coal and 60 pounds of steam per horse power per hour, while the Inch line steamers have been run on a pound of coal and 10 pounds of steam. Combustion motors that some of us can remember weighed 400 pounds per horse power, while the aeroplane motor of today weighs about 3 pounds per horse power. In electro-mechanical conversions we get an efficiency of 95 per cent easily. It is not a matter of opinion, but of fact, that we have but a small margin of unrealized achievement to draw upon

here. Our statement was that in most of the mechanical and physical elements employed in aviation, the margin seems to be similarly small, compared to the enormous margin of unsolved difficulties that lies between the brilliant aeroplane performances of today and the real "conquest of the air"—a conquest as sure as that by which the "little cargo boats" may "sail the wet seas round."

In all the cases cited by our critic, and in any analogous ones we can recall, the achievement of a new order was secured by using an agency of a new order, an agency different not in degree but in kind. When human limitations had been all but reached, man turned to the horse—a motive power so different, so much larger, that even in its primitive performances it set new records; and then, by breeding and training, the horse was continuously improved. Next came wind, water, and steam—each in order of its own, even in crude form leaping easily to a new plane of performance on which it afterwards rose by successive refinements. So mechanical transmission gave way to electrical, and signalling to telegraphy—advances not of degree but of kind.

The horse handled very heavy loads, on rails, and attained a very high speed, when carefully bred and trained and placed upon a proper track; but no glorification of the race of horses would produce a power that could run the Twentieth Century Express, drive the Lusitania, or handle the commercial traffic of today. While the case is not closely parallel, we seem to be trying, in aviation, to do something like this. We seem to be attempting the solution of problems of a new order by the agencies of the old. It would be rash to assert that the problems will never be solved, but there does seem to be reason for holding that the forces and conditions to be met are of a new order, and that the practical conquest of the air depends on some achievement of a new order both as to power and materials.

In performances notable not for kind so much as for degree, the near future promises several items of interest. One is the removal of the old locks at Lockport, once regarded as one of the wonders of America, and their replacement by hydraulic lifts. Another is the raising of the Maine, for which an original plan is proposed by Mr. John F. O'Rourke. He would build wharves of piling parallel with the sunken hull on both sides, sink six pneumatic caissons between each wharf and the ship, and drive many small tunnels beneath the keel, from caisson to caisson. Through these tunnels cables would be passed, suspending the hulk on a system of slings placed a few feet apart. By tautening the cables by screw-jacks worked by hand the vessel would be raised "completely out of the water, where a complete inspection of her hull would be possible. Once above the water line, the gap between the wharves would be bridged and the engineers would work under and around the hull. When repaired she could be let down into the water by a reversal of the process. After being relaunched she can leave Havana harbor under her own steam."

It is said the plan will be referred to a board of Army engineers, for full consideration. It certainly is interesting, and if feasible, would permit such examination of the hull as could be secured in no other way, settling finally the cause of the melancholy disaster. It would seem, however, to invite serious difficulties from conditions characterizing the harbor bottom. The vision of the Maine returning "under her own steam" is perhaps remote. After the explosion and twelve years at the bottom of Havana harbor, the services of a well-equipped dockyard in close proximity would certainly be needed before the ship could steam, or even float.

REVIEW OF
THE ENGINEERING PRESS.
"THE WORLD IS ITS FIELD"

THE ELECTRIFICATION OF RAILWAYS.

THE IMPERATIVE NEED FOR THE SELECTION OF A SYSTEM FOR UNIVERSAL USE.

George Westinghouse—American Society of Mechanical Engineers.

THE share of Mr. George Westinghouse in the development of electrical machinery on the one hand, and of railway apparatus on the other has been such as to make any opinion he expresses concerning the problems of railway electrification of transcendent interest. In a paper read at the recent joint meeting of the American Society of Mechanical Engineers and the Institution of Mechanical Engineers he deals with the standardization of the electrical equipment of railways, a subject which has been under active discussion for some years past. Mr. Westinghouse believes that the time has come when the adoption of a universal system of electrification is imperative; his paper is a plea for the "early selection of a comprehensive electrical system embracing fundamental standards of construction which must be accepted by all railway companies in order to insure a continuance of that interchange of traffic which, through force of circumstances, has become practically universal, to the great advantage of transportation companies and of the public."

The fundamental requirements to insure interchangeability of traffic in steam operation are five: (*a*) a standard gauge of track; (*b*) a standard or interchangeable type of coupling; (*c*) a uniform interchangeable type of brake apparatus; (*d*) interchangeable heating apparatus; and (*e*) a uniform system of train signals. Electric operation introduces three further fundamental requirements: (*f*) a supply of electricity of uniform voltage and periodicity; (*g*) conductors uniformly located with reference to the rails; and (*h*) uniform apparatus for control of electric supply.

The development of systems for the electrification of railways has followed the demonstration of the properties of alternating currents, of the steps in which Mr. Westinghouse gives a brief historical review. Three important systems have been put into practical operation, all using alternating current wholly, or in part. These are: (*a*) the continuous- or direct-current system (commonly called the "third-rail" system), which employs alternating current for transmitting power when the distance is considerable; (*b*) the three-phase alternating-current system with two overhead trolley wires; and (*c*) the single-phase alternating-current high-tension system with a single overhead trolley wire. The power-house equipment is essentially the same in the three system, but the systems differ in the kind of motors and controlling apparatus used and in the methods and apparatus for current transmission.

The essential requisites in a railway motor are ability to start under load, rapid acceleration, and ability to operate continuously at any desired speed or speeds. The capacity of the steam locomotive depends upon its boiler capacity; that of the electric locomotive on the capacity of the motors, which is usually fixed by the heating of their coils. The three types of motors have certain fun-

damental differences in speed performance which are important factors in determining the advantages, disadvantages and limitations of the several systems. The direct-current series motor automatically adjusts its speed in accordance with the load, the speed with any given load being definite, dependent upon the voltage applied to the motor. The speed may be decreased by the insertion of resistance in the motor circuit, a wasteful and inadmissible expedient, or by connecting two or more motors in series. As the system of current supply involves a fixed voltage, however, no speeds much above the maximum for which the motor is designed can be obtained. The

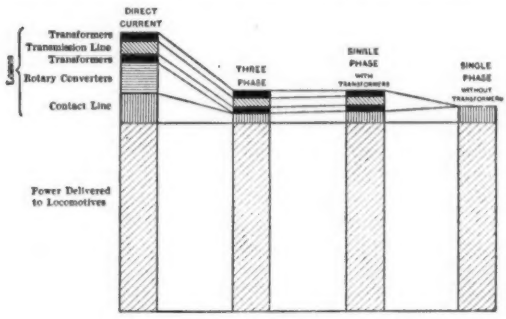


FIG. 1.

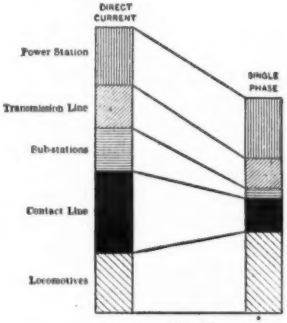


FIG. 2.

three-phase motor, on the other hand, is inherently a constant-speed machine; by no means can the speed at light load be made appreciably higher than it is at full load. Speed can be reduced, however, by either of the methods noted above, or by special arrangement of the motor, although the latter method involves some complication in windings and connections. Three-phase motors have the advantage that on descending grades they may be used as generators, returning power to the line.

The speed characteristics of the single-phase motor are very similar to those of the direct-current motor, the speed at a given load depending directly on the voltage. The voltage, however, is not limited to that supplied by the circuit, or to one-half or one-quarter of that voltage, as in direct-current motors, but may be adjusted to any desired degree of refinement by means of auxiliary connections from the secondary winding of the transformer on the locomotive. The wide range of efficient speed adjustment, both above and below the normal, is one of the especially valuable features of the single-phase system. The choice of frequency for use on single-phase railways is one of the most involved, difficult and important problems now presented for solution. Twenty-five cycles is the rule for power transmission. This frequency has been adopted on nearly all the single-phase railways now operating. The Midi Railway of France, however, has adopted fifteen cycles, the frequency employed in nearly all three-phase systems. The lower frequency permits of a marked reduction in the size of the motor for a given output.

The controlling factor in the cost of electrification in nearly all cases is the system for transmitting power from the power house to the locomotive, and not the locomotive itself. In ordinary practice alternating current is generated no matter what the system. In the direct-current system the apparatus intervening between the generator and the locomotive, through which the energy must pass, are: (*a*) raising transformers in groups of three; (*b*) a three-wire transmission line and substations, which require attendance, containing (*c*) transformers in groups of three and (*d*) rotary converters; (*e*) a third-rail contact conductor which for heavy work must often be supplemented by copper feeders; and (*f*) the track return circuit, provided with heavy bonds, which must be supplemented in certain cases by feeders and so-called negative boosters. The alignment of the third rail must be maintained within close limits both in its distance from the track rails and in its ele-

vation above them, as the contact shoe can have only a small range of automatic adjustment.

The three-phase system requires no rotary converters, the track return usually requires only inexpensive bonding, and the contact system consists of two overhead wires. Otherwise the transmission apparatus is the same as for the direct-current system. The contact wires require a double system of overhead construction, as they must be kept separate and well insulated from each other. The two wires must be maintained at equal height above the track and at switches and cross-overs the construction is complicated. In the single-phase system there are: (*a*) a raising transformer; (*b*) a two-wire transmission line and substations widely spaced, each containing (*c*) a lowering transformer supplying (*d*) a single trolley wire; and (*e*) a track return, usually requiring only inexpensive bonding. In cases where the distance from the power station is not more than 15 to 20 miles, the trolley wire can be supplied directly from the power house. The single wire permits a relatively wide range in height, as the pantagraph trolley automatically adjusts itself to the position of the trolley wire.

The three types of railway motors and the corresponding transmission systems have all successfully demonstrated their ability to operate railway trains. It is not Mr. Westinghouse's purpose to urge the adoption of any particular system, but to point out the characteristics of the systems which have a bearing on their limitations and adaptability to railway conditions, and to urge the gain which will result from a single universal system. He enumerates five prime requisites of a satisfactory universal system:

(*a*) The electric locomotive should be capable of performing the same kinds of service which the steam locomotive now performs. It will do this most easily by practically duplicating the speed and power characteristics of the steam locomotive. The wide range of performance will call for wide variation in tractive effort and in speed.

(*b*) The electric locomotive should be capable of exceeding the steam locomotive in its power capacity, to handle heavier trains and loads and to operate at higher speeds.

(*c*) The electric system should adapt itself to requirements beyond the ordinary limitations of the steam locomotive in small as well as in large things. It should be adaptable to use on branch lines, and to light passenger and freight service similar to that so profitably conducted by interurban electric roads.

(*d*) A universal system requires that power should be transmitted economically over long distances.

(*e*) The contact conductor should be economical to construct for both light and heavy service; it should impose minimum inconvenience in track maintenance, give minimum probability of disarrangement in case of derailment or in snow and sleet storms, and in general be so constructed as to insure to the highest degree possible continuity of service.

"The use now made of electricity in steam-railway service has been brought about, generally speaking, through compulsion. The steam locomotive has reached its limitations and has been found unsuitable and inadequate in tunnels or in terminal service. Even where other considerations may have been controlling, the problem has usually been a specific one of electrifying a relatively small area. The problem has been solved by considering those factors which were of immediate importance, without giving weight to uniformity with other systems or to extension. Now the natural course of development will be the extension of these limited zones, until after a time they meet. Then there will arise great inconvenience and expense if the systems are not alike. In the early days of railroading, it was of little consequence whether the tracks of the different systems in various parts of the country were alike or unlike, but later it did make a vital difference, and the variation resulted in financial burdens which even yet lie heavily on some railways. It is this large view into the future of electrical service which should be taken by those responsible for electric railway development."

Complete electrification of a railway will introduce many changes in operat-

ing practice; elimination of coaling and watering places, different composition of passenger trains, more frequent operation, heavier trains, higher speeds and the introduction of through service on branch lines will give rise to many new problems. Freight will be moved in much heavier trains than are possible with the steam locomotive. A large percentage of shunting operations due entirely to the use of steam locomotives will no longer be required.

With the adoption of a universal system the railway companies can effect large savings in capital expenditures by the adoption of some co-operative plan for the generation of electricity. They

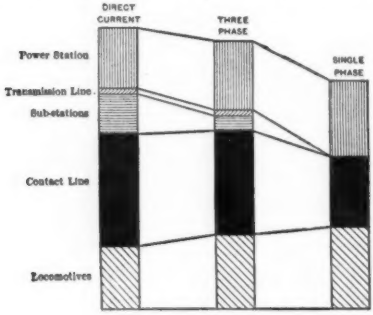


FIG. 3.

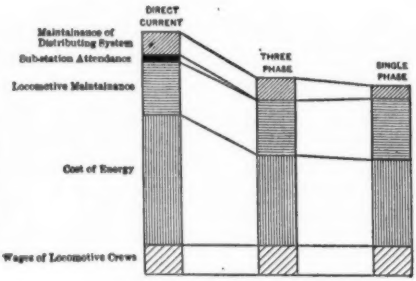


FIG. 4.

can utilize their own rights of way for the transmission of current, not only for the operation of trains but for many other useful purposes. The reduction of the cost of generating electricity through the development of gas and oil power will accelerate the work of electrification.

Mr. Westinghouse perceives that there will be serious difficulties to surmount in the selection of a general system. Each of the existing systems will have its partisans, there will be many advocates of the common view that there is room for several systems, controversies on minor details will cloud the main issue. If there were only one system to be considered, however, there would be a concentration of energy on the perfecting and simplifying of the apparatus for that system, to the advantage of both railway companies and manufacturers.

Five appendices are added to Mr. Westinghouse's paper. The first describes the single-phase system on the New York, New Haven and Hartford Railroad. The second gives detailed data and many photographic illustrations of American designs of locomotives for heavy service. In Appendix III the three systems of electrification are compared; diagrams show the arrangement and apparatus of transmission circuits and substations, and the comparative losses and first and operating costs of the three systems. Appendices IV and V give, respectively, data of existing electrified steam roads and electric roads for trunk-line operation, and a brief review of the early history of the single-phase railway motor.

The diagrams reproduced above are taken from Appendix III. Figure 1 shows the comparative losses between the generators and the locomotives for each of the three systems, in a class of service where the input to the locomotives by the several systems is practically the same. Figure 2 shows the comparative first costs of the direct-current and single-phase systems for 100 miles of single-track railway with through and local freight and passenger traffic handled by 20 locomotives. Figures 3 and 4 show, respectively, the first cost and the operating cost of the three systems for a special case of pusher service on mountain grades employing 12 locomotives. The line is 32 miles long, part single track, part double track and part triple track. Including a large yard, there are 90 miles of single track. The generating station is so located that substations are necessary with direct and three-phase current but not with single-phase.

ELECTRO-MECHANICAL LOCOMOTIVES.

A BRIEF REVIEW OF SYSTEMS OF ELECTRO-MECHANICAL PROPULSION FOR LOCOMOTIVES ABOUT TO BE PUT TO PRACTICAL TEST.

A. P. Chalkley—Cassier's Magazine.

WE noted in these columns in our July issue that electro-mechanical marine propulsion is soon to be given a trial on a considerable scale. From a brief article by A. P. Chalkley in *Cassier's Magazine* for June we learn that similar progress is being made in the application of electro-mechanical propulsion to locomotives. Mr. Chalkley estimates the saving in operating cost of the electro-mechanical system using steam turbines at 32.5 per cent., and using Diesel engines at 37 per cent., over the reciprocating steam locomotive. We quote from his description of the three leading systems, of which at least one, the Reid-Ramsay, has already been put to practical test.

"In 1905 a system was patented by Mr. McNulta, which apparently has never been put into practice, but which possesses great originality. Two vertical turbines of the Parsons type were coupled to the external armatures of alternators, the internal field magnets being keyed on to shafts revolving within the turbine shafts and coupled to two driving axles of the locomotive through bevel gearing. There were also motors on the other axles, taking their power from the secondaries of static transformers, the primaries of which were connected to the terminals of the alternator armatures. The field magnets of the alternator were excited from a separate steam-driven exciter. On starting up the turbines, the outer armatures were rotated, and when the field magnets were excited current was generated in the armatures and delivered to the motors through the transformers. The field magnets also revolved, and, as the speed of the locomotive increased, the relative speed of rotation of the magnets and the armatures decreased, and the voltage at the armature terminals (and consequently the torque of the motors) diminished, that is to say, the highest torque was developed at the start and was reduced as the speed rose. Variations of torque, according to the conditions, were obtained by a controller, which altered the ratio of transformation.

"Probably the first electro-mechanical locomotive to be built has been constructed at the works of the North British Locomotive Company at Glasgow, in accordance with the designs of Messrs. Reid and Ramsay, and tests have recently been carried out. A single horizontal turbine of the Curtis type is employed to drive a direct-current series dynamo, from which power is taken to four or more series-wound motors coupled to the driving axles through gearing in oil boxes. The steam, after passing through the turbine, enters a jet or ejector condenser, where it is condensed and mixes with the condensing water. The whole is then pumped by means of turbine or reciprocating pumps through the cooling apparatus mounted on the front of the engine, so as to obtain the full blast of the air when the train is in motion. Cooling may also be facilitated by a turbine-driven fan, forcing the air over the water, the same or another fan being used to cause a draught in the boiler furnace. The water, after being cooled, drops by gravity into a supply tank, and part is pumped back into the boiler through a feed heater, and part used for condensing purposes again, the supply tank being of sufficient capacity to carry the water required for the boiler and to make up any condenser losses.

"A further and most promising system which will soon be put into operation is that of Mr. Durtnall. It is applicable with steam turbines, suction gas engines, or Diesel oil engines, though the latter seem likely to give the best results. The generator consists of two elements, the alternator, with armature and field magnets and the transformer generator. Squirrel-cage induction motors are all used on the axles. Both the rotating elements of the generator are on the same shaft, which is coupled to the prime mover; an exciter delivers current to the

field through the slip rings. The design of the machines depends on the conditions of running and the speed required. If the prime mover is a Diesel engine working at, say, 400 revolutions per minute, the alternator may be a 4-pole, the transformer a 12-pole, and the motors 20-pole machines. To obtain the lowest speed of the motors, the current is taken direct from the armature of the alternator to them, when a synchronous speed of 80 revolutions per minute is produced. For the next speed the current, instead of passing direct to the motors, is led to the primary of the transformer generator, so that the flux due to it revolves in a direction contrary to that produced by the rotation of the primary itself. The periodicity of the current taken from the secondary of the transformer generator is, therefore, equivalent to that of an alternator with 12 minus 4, i. e., 8 poles, so that the synchronous speed of the motors is 160 revolutions per minute. The third and top speed is reached by sending the current into the transformer generator, so that the direction of rotation of the flux due to it is the same as that of the primary of the transformer generator. The synchronous speed of the motors is now the same as if the power were obtained from a 12 plus 4, i. e., a 16-pole generator, and will be 320 revolutions per minute. Intermediate synchronous speeds can be obtained by mounting the armature on bearings, and providing it with a pair of slip rings, and varying the speed mechanically to any required extent. Reversing is accomplished by simply reversing two phases by means of a change over switch. The figures given above are, of course, purely illustrative, and it would probably be found in most cases that higher speed motors would be more satisfactory and economical, gearing being employed to reduce the speed of the axles to the workable limit."

THE ENGINEER'S DUTY AS A CITIZEN.

A PLEA FOR THE ACTIVE PARTICIPATION OF ENGINEERS IN PUBLIC AFFAIRS.

Rear-Admiral George W. Melville—American Society of Mechanical Engineers.

ENGINEERS have begun to demand for their profession the recognition to which it is entitled by reason of the predominance of scientific progress among the influences affecting the advance of human civilization. They commonly forget, however, that rank has its obligations, that public recognition imposes public duty. It cannot be too often reiterated that engineers should accept as a part of their professional duty the obligation to participate in the discussion and administration of public affairs when sound technical knowledge is essential to the formation of a correct judgment by the public.

In a recent address before the American Society of Mechanical Engineers, Rear-Admiral George W. Melville cites a number of recent cases in which the civic duty of the engineering profession is plainly apparent. "In view of the enormously important part which the engineer plays in the life of today," he says, "it is incumbent upon him, more than upon most other men, to take a vital interest in the work of government and to lend his trained ability and judgment to its perfection. I do not mean, of course, that the engineer should do routine professional work for the government without compensation, but that in the discussion of public improvements and the administration of governmental departments, he should take an active public stand to influence and guide the non-expert part of the population.

"It is notorious that enormous amounts of money have been squandered on great public works because they were undertaken in a way which every engineer knew must be inefficient and uneconomical. If all of us as engineers had a keen sense of our duty in this respect, and would properly utilize our experience and ability through the daily press, the magazines and the reviews by public discussion and in the daily intercourse of life, as well as by impressing the truth upon our representatives in municipal and national affairs, I believe we would accomplish an immense good.

"A problem of foremost importance at the present time is the management of labor to secure efficient work and satisfied men. It is probable that the direction of more than 90 per cent. of the skilled labor is in the hands of engineers. Most emphatically is this a case where engineers owe a great duty to society. It would be inappropriate in this brief address to attempt a detailed discussion of the labor problem, but I feel that I shall voice the sentiment of every one present when I say that the effort of every American should be exerted to maintain absolute freedom of contract in labor matters as in all others. Just as we are opposed to monopoly by capital, so we are to the same thing by labor.

"No reasonable man objects to labor organizations, as such. They have undoubtedly been the cause of much benefit to the men. The danger with them, as with political organizations, is the formation of a machine which utilizes the organization solely for the selfish interests of the members of the machine. There can be no doubt whatever that many strikes are against the real wishes of a majority of the men, who are overborne by the machine and its adherents; and it is also true that the net result of nearly all strikes is an actual loss to the men. The problem is an exceedingly difficult one and requires the greatest wisdom, patience and tact for its complete solution; if, indeed, taking human nature as it is, we can ever hope for its removal from the list of worries of the manager of great enterprises.

"Many questions prominently before the public are peculiarly such as require engineering knowledge for their proper understanding and regulation. The word trust has come to have such a sinister meaning that it is only necessary to fasten it upon an enterprise to render it criminal in the popular estimation. We have recently heard a great deal about the so-called Water-Power Trust, the charge being that all the available power sites were being grabbed so as to subject our citizens at some future time to the payment of tribute for electric power derived from them. I am not concerned, at the moment, with a discussion of monopolies, which we all deprecate, but to point out that engineers know these water powers cannot be made available except by the expenditure of large sums of money. Indeed, it would be easy to point out the fortunes that have been lost in the attempted exploitation of these supposedly lucrative natural gifts. The general public is utterly misled by statements that these power sites are obtained for nothing, the idea being that the development is a matter of small expense. Here the engineer can do a work of real benefit by disseminating correct information.

"Again, in the consideration of public-service corporations, the engineer knows the cost of installation and operation, and so can discuss intelligently whether rates are fair or exorbitant, and whether capital represents real investment or water. These are problems of the greatest importance, and for their proper solution, the electorate needs training that can be given by no one else so well as by the engineer.

"About a year ago, at our Washington meeting, I did what I could along this line by pointing out mistakes in connection with navy yard organization, and this illustrates very clearly what I am advocating for all engineers. Here was a great department of the Government for which the annual appropriation now exceeds $100,000,000. Its administration had fallen into the hands of a man who started to make changes in the entire administration which would have been ruinous to efficiency; and yet, hardly a voice was raised in opposition. I even heard of a case where one of our leading engineering journals refused to publish a criticism of this system submitted to them through a man whom they knew and esteemed most highly, but who stated that the author was so situated that he could not permit his name to be used. Not only would the magazine not print the article, but they did not take enough interest in this most important subject to study it for themselves and comment upon it.

"I do not mean to imply that engineers never show public spirit in such ways as I have suggested; there are too many instances to the contrary. These,

however, are mostly cases of unusual importance and relatively infrequent. What I am pleading for is a habit of mind that will cause engineers to take an active part in all public questions, great or small, where their knowledge and experience will enable them to contribute to the common good.

"The movement which has been set on foot by Congress to establish a Bureau of Mines suggests an opportunity for the engineer to take an active part in public affairs. I question whether this idea might not be developed a little further by providing for a department with a Cabinet officer at the head, to be called the Department of Mines and Manufactures, with the scope implied by the title.* When we think of the enormous values represented by the industries which would come within the purview of such a department, it seems only reasonable that they should be under the care of a Cabinet officer. If we are told that there is already the Bureau of Corporations, I would point out that the object of this proposed new department is quite different from that of the existing bureau which thus far, in the estimation of many, has done little or nothing to advance the interests of manufacturing, but has, in their opinion, disclosed a spirit which is almost inimical. The department that I have in mind would aim to stimulate improvement and progress in manufactures and industries generally, in somewhat the same way that the Department of Agriculture has done for the farmers.

"We have often heard engineers complain that the profession did not receive due praise and credit for its splendid work. This is true enough, but is the reason not very largely because the engineer hitherto has been content to do the work and then fade into the background, leaving the talking and the management to the lawyer and the politician? With the advance of technical education, engineers are more and more becoming the high officials of our large corporations. It is to these men, whose talents and trained ability have made them the leaders in manufacturing and in business, that the country has the right to look for leaders in the affairs of government, and not until the engineer of all grades has done his part towards the promotion of the highest efficiency of the Government can he truly say that he is, in the fullest sense, a good citizen of the Republic."

* Since this address was prepared, the bill in Congress referred to above has become a law. The newspapers have published an item that consideration was being given to the formation of a Department of Public Works. This is along the same general line as my suggestion above for a Cabinet officer to head a Department of Mines and Manufactures.

THE VALUE OF WATER POWER.

THE EFFECT OF RECENT ENGINEERING PROGRESS ON THE VALUE OF WATER POWER.

Engineering News.

AN editorial article in *Engineering News* for June 23 directs attention to a phase of the long-debated question of the value of water power which is commonly overlooked. In the opinion of the writer, by the public at least and probably by a large part of the engineering profession as well, there is not sufficient appreciation of the effect which recent developments in mechanical engineering have had upon the value of water powers. The prominence of water power in the conservation movement lends the subject an importance quite apart from its technical interest; we quote at length from *Engineering News.*

"The value of undeveloped water powers is to-day much less than it was 15 or 20 years ago. The cause of this decrease in value of water power is the great reduction in the cost for which power can now be developed by other prime movers. This fact is one of great public importance, and one on which the public ought to be informed. There never has been a time when the development of water power has been more prominent than at the present time. It is one of the most important features of the so-called conservation movement. The claim is made that the undeveloped water powers which are still owned by

the states or the nation are of such vast value that they should not be allowed to pass into private hands in perpetuity, but should be leased under reasonable restrictions, and the title to them should be retained by the public.

"We have in the past expressed general agreement with this view, which is held, we believe, by many members of the engineering profession; but it ought to be understood that the importance of public control of water power is in the distant future rather than in the present. It ought to be more clearly understood that in most locations and under most circumstances it is exceedingly difficult to develop water power and make a good profit on the capital invested. Any public revenue derived from water powers will have to be merely nominal for many years to come, or their development will be greatly hampered.

"Again, it is important that investors should know the real situation with reference to water-power values. The prevalent idea appears to be that the development of a water power is a process of obtaining something of value from Nature without paying for it. The average investor contrasts the fact that with a steam plant, coal must be steadily fed under the boilers and paid for at so much a ton, while with a water power plant the natural flow of the stream constantly turns the wheels. He concludes, therefore, that water power is necessarily cheaper than steam power. He has no understanding of the other elements which effect the problem and which extremely often reverse the comparison.

"The public belief in the great value of water power has been made the basis of a great state enterprise, and it is even proposed that the nation shall become concerned in great water-power development schemes. The State of Illinois has voted $20,000,000 for the creation of a deep waterway from Chicago toward the Mississippi River, and the voters have been given to understand that the water power incidentally developed by the construction of the waterway will be so valuable that it alone will repay the cost of the work. The promoters of great schemes for inland waterways have as one of the stock arguments in their campaign the claim that the great value of the water power developed will repay to the public a large part of the cost.

"Still again, knowledge as to the true value of water power is of great public importance from quite a different point of view. Cities throughout the country, great and small, are engaged in the increase of their water supplies. In many cases it becomes necessary in this work to reduce the flow in a stream which has been used or may be used for power development. The value of water power in such cases becomes often a matter which must be settled by litigation. If the values frequently adopted in compensating the owners of these water powers were the true values, then indeed all the glowing claims of the water-power promoters' prospectuses would be justified, as would all the claims of those who urge the extremest doctrines of conservation. In our opinion, however, most of the awards for damages in water-power cases are much beyond the actual value of the plants taken.

"The development of electric-power transmission some 20 years ago gave a great impetus to water-power development, and made available many powers which had hitherto been practically worthless." . . . But "while the electricians have been busy with long-distance transmission, and the hydraulic engineers with water wheels, development has been going on in other prime movers. The steam turbine, on the one hand, and the internal-combustion engine on the other are the two machines which have well-nigh revolutionized the field of power development in the short space of years since long-distance transmission brought water powers again into active development."

The steam turbine in its first development was not a highly economical heat engine, but in its very recent development, in large units, it is demonstrating itself to be almost certainly the motor of the future. It has the great merit, moreover, of keeping up its economy over a large range of loads. A combined plant of steam engines and low-pressure turbines in New York shows an average steam consumption of 14 pounds of steam per kilowatt-hour. Such a

steam economy as this makes the cost of fuel a comparatively small element in the yearly power bill. The cost of attendance is one of the heaviest items in the cost of power production, and the steam turbine requires small attention. Another great advantage of the steam turbine over all other commercial prime movers is the great reduction in the cost of the generator.

Recent improvements in steam boilers have increased the size of units, improved economy, introduced superheating and automatic stoking and eliminated smoke, but the most important progress has been made in the ability to carry overloads. It is just here that the steam-power station shows to greatest advantage in comparison with the hydro-electric plant. The steam station is frequently designed to carry, for a short time, loads 50, 75 or even 100 per cent. higher than those for which it is normally designed. The water-power plant, on the other hand, on account of the inherent limitations of its machinery, can carry only a small percentage above its normal rating.

"It may be asked how the case stands for small-sized powers, such as those which are commonly met with in the condemnation of water powers by reason of the development of city water supplies. Admittedly, such small water powers, when advantageously located, are often worth a greater sum per horse power than the powers of great size which, if developed at all, must be developed in competition with the large steam-power stations. . . . . For small powers, however, the gasoline engine has practically rendered the steam engine obsolete. For larger powers, the oil engine and the gas engine using producer gas are rapidly gaining in popular favor. The fuel economy of these engines is so excellent that the total cost of fuel per horse power per annum is cut down to a figure nearly as low as that of the highest-class steam-power plants. . . . .

"Thus far, we have been speaking chiefly of the value of undeveloped water power. It ought to be said in addition that the cost of developing water power is very commonly underestimated by the lay public. The old-time development of water power on a small scale for the sawmill or the gristmill was comparatively inexpensive, but was correspondingly inefficient and liable to injury by flood. For a really substantial and reliable development of water power on either a small or a large scale, with proper provision against damage or interruption by floods, and with storage to provide for seasons of low water, it will be found that the cost of water power development per kilowatt or per horse power will almost always be largely in excess of the cost of installation of a steam- or gas-power plant of similar size. This additional investment cost creates an interest charge, which will often offset or more than offset the cost of the fuel for the competing plant.

"Nor is the case against the water power plant all summed up in the above. There are in the steam-power plant waste products in the form of heat, which is often necessary for use in manufacturing processes and must always be supplied, to a greater or less extent anyway, in winter weather. The water-power plant must be debited with this necessary fuel cost in order to compare it with its competitors on an equal basis.

"We have already shown that in nearly all cases where water power is developed on a large scale, the power must be electrically transmitted over long distances, from a few miles to a hundred or even two hundred, in order to reach a market. Such long lines of wire, experience has shown, are more or less subject to accidents, and consequent interruption of the service. So well is this understood that it is becoming a very generally accepted principle that an auxiliary steam plant for emergency service is a necessary part of any successful hydro-electric installation relying on long-distance transmission. That is to say, besides the cost of the water-power development, the long-distance transmission line and the sub-stations for distributing the electric current in the city where it is marketed, steam-power stations must be built in the city supplied and these stations must be ready at all times for an emergency. Such steam stations are generally made use of also to help the water-power plant carry the peak of the

load. It must be understood that the cost of operating steam stations on such service is exceedingly high for the power developed. The capacity of such a station must be equal to the maximum demand, or else some of the customers must be cut off when any accident cuts off the supply from the water-power plant.

"We believe these difficulties ought to be more clearly understood by investors and by the general public. Because of ignorance as to these matters, engineers engaged in water-power development are often unjustly blamed for the financial failure of an enterprise; or if they make a success, they fail to receive the credit which should be given them. It ought to be apparent also that good engineering is a prime necessity if success is to be attained in any water-power enterprise. It takes an engineer of ability and experience to determine beforehand whether a water-power project can be made a profitable enterprise. It takes an equally good engineer to so carry out the work that profits may be secured."

THE EXAMINATION OF WATER BY ELECTRICAL METHODS.

THE VALUE OF CONDUCTIVITY TESTS IN CHECKING THE OPERATION OF STEAM PLANTS, AND A NEW TYPE OF APPARATUS.

W. Pollard Digby—Institution of Electrical Engineers.

THE well known physical fact that the electrical conductivity of distilled water is greatly increased by the addition of even minute traces of impurities is the basis of a simple device for testing water for boiler-feed purposes which recently made its appearance in England. One of the inventors, W. Pollard Digby, has described its construction and uses in a communication to the Institution of Electrical Engineers, which is abstracted in *The Electrician* for July 29. Mr. Digby does not suggest that the measurement of conductivity alone will supersede chemical analysis in water testing; that the electrical method has important supplementary uses, however, is amply evident from an examination of the results quoted in his paper. We are unable to reproduce these results in our review, but we give Mr. Digby's description of the apparatus used in the conductivity test and a few details of its applications.

"That water in its varying degrees of impurity is anything but a medium of constant value comes within the experience of all engineers, and hence frequent resort is made by the engineer to the analytical chemist for advice and assistance. However, this is not always done as often as might be desired, and a variation in the nature of a supply may take place with no visible change in the appearance of the water, but yet with such changes in the constituents as would render the water quite unsuitable for boiler-feed purposes. The author's object is to point out the value of simple tests made *in situ* as safeguarding the owners of boilers from such happenings, and as determining when the analytical chemist should be employed. These tests, however, are not intended in any degree to supersede the analyst, but may serve to determine when detailed analyses are necessary by indicating changes in the impurities in the water. The method resolves itself into a determination of the conductivity of the liquid at any predetermined temperature and a comparison of such determinations with the known values of analysed samples. Any marked variation from the normal should be followed by a further analytical examination.

"An apparatus for conductivity measurements has been devised by Mr. C. W. V. Biggs and the author. The original type consists of a straight glass tube so constructed as to hold the equivalent of a body of liquid 10 centimetres in length and 1 square centimetre in sectional area, the liquid being contained between platinum electrodes attached to plugs of ebonite fixed in cups which form enlargements of the ends of the tube. The electrodes are suitably connected to terminals in the ebonite ends, and are capable of being adjusted. The

liquid to be tested is introduced into the main tube through a small tubulure, rising at an angle from the middle of the upper part; and when tested is run off through a small tube furnished with a tap attached to the middle of the lower part. At each end of the upper surface of the body tube a vent tube is attached, inclining to the middle of the main tube, and the two unite at a height of about 2½ centimetres above it, with a short vertical outlet.

"Manifestly such a piece of apparatus is hardly suitable for use outside the laboratory. The form for practical work consists of a glass U tube, to which is attached at the lowest point of the bend the tube brought from the filling funnel, whilst the outlet, controlled by a glass tap, is joined to the inlet at its lowest point. Near the extremities of the limbs of the main tube overflow ways are sealed on, and terminate in india-rubber tubes grouped with the lower outlet. The form and arrangement of the electrodes are especially designed to minimise the disturbing effects of polarisation and other difficulties inseparable from the original type of tube. The electrodes are open cylinders of platinum, about 9 millimetres in diameter and 3 millimetres in height, connected by three equidistant platinum wires to stout brass glass-covered rods passing through the brass covers which are connected to the terminals. The dimensions of tube and electrodes are such that the equivalent of a body of liquid having a length of 10 centimetres and a sectional area of 1 square centimetre is obtained. The apparatus is mounted on a strong wooden support carrying a thermometer, and the whole is contained in a lock-up portable case.

"The most convenient instrument for measuring the conductance is the 'conductance meter' made for use with the tube. It resembles the familiar 'megger,' but is furnished with a scale graduated in reciprocal megohms and ohms, and with a tube of sectional area one-tenth the length it gives readings of one-tenth of the specific conductivity—equivalent to the reciprocal of 10 times the specific resistance. Correction for variation of temperature for water containing less than 1 per cent. of dissolved salts may be made with sufficient accuracy by taking the coefficient as 2.19 per cent. per 1 degree C., as referred to 20 degrees C.; but above 38 degrees C. such correction is not reliable owing to complications arising from disengagement of small quantities of dissolved gases and also from physico-chemical action.

"At the outset the author experienced considerable difficulty in determining standards for comparison. Of samples passing through the author's hands, good distilled water has varied in its specific conductivity from 4.0 to 1.362 reciprocal megohms for laboratory distilled water, and for distilled water from surface condensers the best has been 3.3 reciprocal megohms. As a general standard of comparison, good distilled water might possibly be defined as possessing a specific conductivity of 3.3 reciprocal megohms, or a specific resistance of 300,000 ohms at about 20 degrees C., this value representing an approximate average value of the output of the Liebig condensers in the laboratory of one of the author's friends, and also representing the best practice from central-station surface condensers that has come under the author's notice."

The effect of minute traces of impurities in greatly increasing the conductivity of distilled water is a well known physical phenomenon. Mr. Digby gives a number of typical results of his investigations of the effect of minute traces of sodium chloride, sodium carbonate and calcium sulphate. The difficulty with the electrical test, of course, lies in the fact that it cannot distinguish between the different impurities. Nevertheless, conductivity tests are of value in detecting variations in the quality of feed water, and in checking the operation of marine evaporators and of evaporators for the supply of distilled water for hydraulic gun mountings. One of their most practical applications is in checking the operation of surface condensers. Given a boiler free from priming, a single conductivity measurement of the water passing from the condenser to the hot well will indicate the tightness of the condenser tubes. If the approximate rate of flow is known at any

moment, together with the value of the circulating water, a reference to standard curves, examples of which are given by Mr. Digby, will give the percentage of leakage at that moment. Conductivity determinations, while indicating that overhauling is necessary, may save unnecessary examinations. Conductivity tests may also be used to indicate boiler priming. If the conductivity of the hotwell water rises as the load on the engine increases, the only possible deduction is that the boiler is priming. Mr. Digby gives the results of a number of tests of boiler plants, which serve to demonstrate the procedure and the utility of electrical tests for this purpose.

"So far as checking the operation of steam plants by conductivity methods is concerned, their application does not cease with checking the nature of the feed water or with ascertaining condenser tightness, or even with defining boiler priming. A film of oil is more to be dreaded than scale-forming impurities in the management of boilers. An oil eliminator in one form or another is a necessary adjunct in all electricity-supply stations containing reciprocating sets, but their careless operation in a manner other than that designed by the makers may involve the substitution of a less evil for a greater one. The author has good reason to believe that in certain cases an excess of chemicals is added beyond that required for the elimination of the oil. This in cumulative small doses can only result in the increasing impurity of the boiler water through its enrichment with a substance which by common consent is regarded as a source of priming.

"A last point may be mentioned. Where hard waters containing an excessive quantity of calcium and magnesium carbonates are softened by the Clark process, the conductivity tube and conductance meter can be used as a substitute for the standard soap test in defining how far the process of softening has been carried."

WATER REQUIREMENTS OF SURFACE CONDENSERS.

AN ANALYSIS OF THE EFFECT OF THE OUTLET TEMPERATURE OF THE CIRCULATING WATER ON THE QUANTITY OF WATER REQUIRED.

R. M. Neilson—The Engineer.

REDUCTION of the quantity of circulating water required to condense a given amount of steam is one of the most important results of recent progress in surface-condenser practice. Broadly speaking, the reduction of circulating water to a minimum is desirable, but there are economic limitations to the degree to which it may profitably be carried. The quantity of water which is satisfactory in one case may be very unsatisfactory in another, even if the vacuum, the inlet temperature of the circulating water, and the steam to be condensed are the same in both cases. The saving resulting from the reduction of the quantity of condensing water may not compensate for the cost of the increased cooling surface required.

The quantity of water to be employed should be determined before the condenser is designed, so that a suitable velocity through the tubes may be chosen. In *The Engineer* for June 17, R. M. Neilson demonstrates the dependence of the most economical quantity of circulating water for any given case, on the best value for the difference between the temperature of saturated steam corresponding to the vacuum in the condenser, and the temperature of the outlet water. He shows clearly the great variation of the latter value in different cases and gives an analysis of the method of determination, which is reproduced in brief below.

To determine the quantity of circulating water, the inlet and outlet temperatures of the water and the quantity of steam to be condensed in a given time must be known or assumed. The determination of the outlet temperature is most important, since the outlet temperature affects not only the quantity of water required but also the amount of

cooling surface. The calculation of the circulating water, based on the data mentioned and on the fact that the heat absorbed by the water equals the heat lost by the steam, is very simple.

Let t_i and t_o be, respectively, the inlet and outlet temperatures of the circulating water in degrees F.; W, the weight of steam to be condensed per hour in pounds; L, the latent heat of steam in B. th. u. per pound; Q, the weight of water circulating per hour in pounds; θm, the mean difference in temperature between steam and circulating water in the condenser in degrees F.; S, the area of cooling surface in square feet; K, the amount of steam, in pounds, which can be condensed per square foot of cooling surface per hour per degree F. difference in temperature between steam and water—a value depending on the pressure of the steam, the amount of air, the velocity of the circulating water, the cleanness and diameter of the tubes, and the general design of the condenser; t_v, the temperature of saturated steam corresponding to the vacuum; δ, the difference between t_v and t_o; and v, the velocity of the circulating water in feet per second.

If all the steam admitted were condensed and the water of condensation withdrawn at the boiling point corresponding to the condenser vacuum, we should have

$$Q = \frac{WL}{t_o - t_i}$$

In practice, however, these ideal conditions are never realized and this equation cannot be expected to give exact results. It is, in fact, useless to hope to get exact results by calculation. It is usually desirable in condenser design to allow rather for an excess than for a scarcity of circulating water, and a convenient equation for the determination of Q is

$$Q = \frac{1{,}000\ W}{t_o - t_i}$$

in which W is not the steam alone but the steam plus water admitted to the condenser in the steam.

The transmission of heat from the steam to the water is approximately proportional to the mean difference in temperature (θm) between the steam and the water. The exact determination of θm involves taking into account the air, which, at the air-pump suction end of the condenser, represents a considerable proportion of the air-steam mixure. A simple and convenient formula is

$$\theta m = t_v - \frac{t_o + t_i}{2} - C$$

where C is a constant depending on the design of the condenser, the capacity of the air pump, and the air richness of the steam entering the condenser, usually having a value between 1 and 5. θm having been determined, S can be obtained from the equation

$$S = \frac{W}{K\theta m}$$

An examination of the formulæ given above will show how the value of δ affects S and Q. A low value of δ imposes a relatively small quantity of condensing water but a relatively large area of cooling surface; a high value of δ, a small area of cooling surface but a large quantity of condensing water. Any value of δ from zero up to the difference between t_i and t_v may be chosen and the temperature obtained under any given conditions by providing a condenser of suitable design, with sufficient cooling surface and circulating water. In general, if δ is to have a value near its possible maximum, the condenser tubes must be of large diameter in proportion to their length, and the water must pass through them only once; if, on the other hand, δ is to have a value approaching zero, the tubes must be long in proportion to their diameter or the water must make many passes through them, and a counter-current action is necessary.

The determination of the best value of δ for any case involves a comparison of the cost of the condenser cooling surface with the cost of the pump and the motor that drives it, the cost of the steam or electric energy required by the pump motor, and the cost of the condenser water or the cost of cooling it for repeated use. The plant load factor, of course, must always be consid-

ered. The velocity of the circulating water has some influence on the best value of δ, but within the limits usually adopted its effect is not of very great importance. The most important factor is the height to which the condensing water has to be pumped before admission to, or after discharge from, the condenser, and the frictional or other losses external to the condenser which affect the head against which the circulating pump has to act. If the total head external to the condenser is great, it will be advisable to reduce to a minimum the quantity of circulating water, even if this reduction involves considerable increase in the cost of the condensing plant. If, on the other hand, the external head is very small, and if the charge for water amounts to little or nothing, δ should be given a high value in order to reduce S.

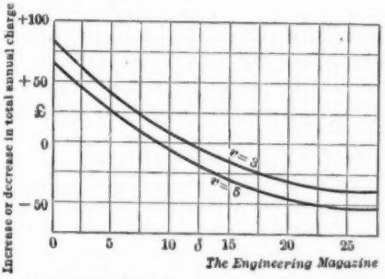


FIG. 1. EFFECT OF δ ON TOTAL ANNUAL CHARGE FOR PLANT LOAD FACTOR OF 10 PER CENT. AND NO EXTERNAL HEAD.

Figures 1 and 2 show the best values for δ when the water has to be pumped through the condenser but not against any outside head. This case occurs when the source of the condensing water is so located that a statical head is obtained, either on the admission or on the discharge side of the condenser, sufficiently large to overcome the friction in the admission and discharge pipes, but not the friction within the condenser. The diagrams have been prepared for cases in which the pressure of steam within the condenser is 1.5 pounds absolute—the corresponding temperature being 116 degrees F.—and the circulating water enters the condenser at a temperature of 82 degrees F. The capacity of the plant is 56,000 pounds of steam per hour. The frictional head within the condenser varies with the velocity of the circulating water; the pump power varies with the head and with Q, the latter varying with δ.

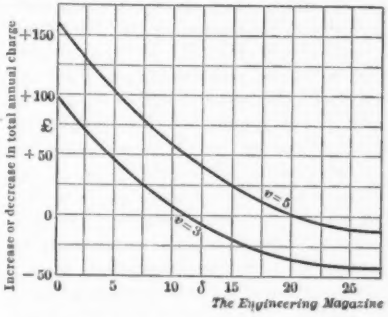


FIG. 2. EFFECT OF δ ON TOTAL ANNUAL CHARGE FOR PLANT LOAD FACTOR OF 33 1/3 PER CENT. AND NO EXTERNAL HEAD.

The ordinates in the figures represent the annual charge, taking into account, not only the cost of pumping, but also the costs of interest, repairs, depreciation, taxes, etc., which are taken at 15 per cent. of the initial cost of the plant. Instead, however, of expressing the total annual charge, the ordinates express only the difference between the total value of δ and the total charge when $\delta = 11$ and $v = 3$, these conditions being taken as standard for the sake of comparison. The cost of pumping has been taken at ¾d. per hydraulic horse power hour. Two values of v have been taken, 3 feet and 5 feet per second. No velocity far removed from these figures is used in practice. Curves for slightly lower or slightly higher velocities than 3 and 5 feet per second or for intermediate velocities are of the same general nature as the curves shown.

It will be seen that the best value for δ is at the extreme right of the curves. In Figure 1 a low plant load factor (10 per cent.) has been taken; a much higher load factor (33 1/3 per cent.) has been assumed for Figure 2. The plant but has little effect on the value of δ. which lies in all cases between 25 and 30 degrees. In Figure 1 the curve showing a velocity of 5 feet per second is lower than the other; in Figure 2 the positions are reversed.

The curves in Figures 3 and 4 are calculated from the same vacuum and inlet temperatures of circulating water as those in Figures 1 and 2, but in these cases the use of cooling towers is assumed and the initial cost of the towers and the cost of pumping water through them is taken into account. It is usual with natural-draft cooling towers to lift the water about 25 feet above the level of the pond below the tower; allowing for pipe friction, etc., the external head against which the condensing water has to be pumped is taken at 35 feet. The curves prepared to suit these conditions are very different from those in Figures 1 and 2. The best value of δ, instead of being between 25 and 30 degrees, is between 0 and 5 degrees. The great cost of pumping the water through the tower and the cost of the tower itself, both dependent on the quantity of water dealt with, make it desirable to reduce the circulation of water, even at the expense of increasing the cooling surface of the condenser.

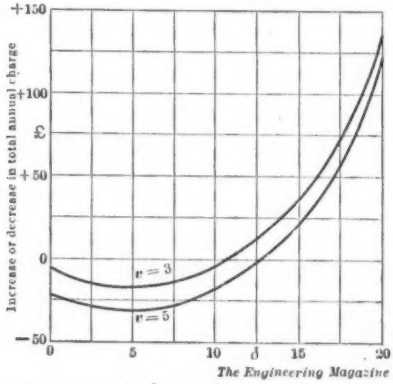


FIG. 3. EFFECT OF δ ON TOTAL ANNUAL CHARGE FOR PLANT LOAD FACTOR OF 10 PER CENT. AND AN EXTERNAL HEAD OF 35 FEET.

The conditions assumed for Figures 1 and 2 represent one extreme; those for Figures 3 and 4 very nearly the other extreme. When the conditions are between those assumed for the two sets of curves, the best value for δ will, of course, occupy an intermediate position. While these curves have been prepared for a pressure in the condenser of 1.5 pounds absolute, they would apply fairly well to cases in which the inlet temperature of the condensing water was higher or lower than 82 degrees F., if the steam pressure in the condenser were so altered that the steam temperature was correspondingly raised or lowered. The cost of the condenser, however, rises slightly with increase in vacuum, but a vacuum much above 27 inches is hardly ever desirable with cooling towers.

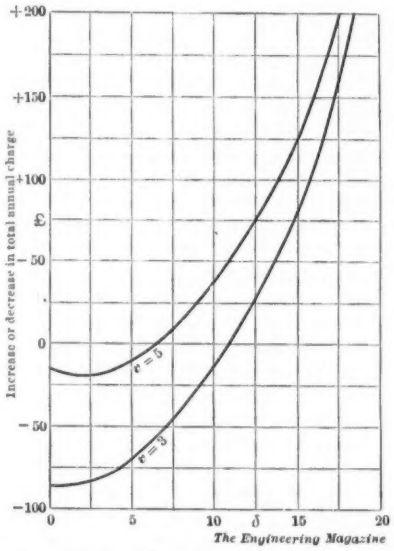


FIG. 4. EFFECT OF δ ON TOTAL ANNUAL CHARGE FOR PLANT LOAD FACTOR OF 33 1/3 PER CENT. AND AN EXTERNAL HEAD OF 35 FEET.

The cost of hydraulic horse power has the same effect upon the best value for δ as the plant load factor. For example, there is the same difference between 0.5d. and 1.6d. per hydraulic horse power hour as between 10 per cent. and 33 1/3 per cent. plant load factor.

"It is evident from an inspection of the figures that one design of surface condenser cannot be best under all conditions. For use with cooling towers, or in any case where the external head is great, a design of condenser should be employed in which the length of the tube elements is great in proportion to the diameter of the tubes, so that δ has a low value, and a relatively small quantity of water suffices. When, on the

other hand, the external head is small, the length of the tube element should be less for the same tube diameter, so that δ is much increased, and the cooling surface of the condenser can be very considerably reduced. The conditions under which condensers on land work vary greatly. With marine condensing plant the conditions do not vary quite so much, but even here the external head varies. Moreover, the vacuum depends on whether piston or turbine engines are employed; and t_t depends on the latitude, etc., and on the season."

ILLUMINATION REQUIREMENTS IN STREET LIGHTING.

AN ANALYSIS OF THE PROBLEM OF SECURING UNIFORMITY OF ILLUMINATION WITH ELIMINATION OF GLARE.

Arthur J. Sweet—The Franklin Institute.

SOME plain criticism of American practice in street lighting, addressed to the American Society for Municipal Improvements by Dr. Louis Bell, was printed in these columns of THE ENGINEERING MAGAZINE for March last. Dr. Bell's chief complaint is against the lack of careful discrimination in the adjustment of illumination to the needs of various classes of streets, but he finds much to criticise also in the methods of light distribution and measurement. In short, streets are lighted but not illuminated. In a paper before the Franklin Institute, printed in the *Journal* for May, Arthur J. Sweet predicts a change in this condition. We are standing to-day, he says, in the dawn of a new epoch—the epoch of street illumination as contrasted with street lighting. He analyzes the problem of securing uniformity in street illumination and of eliminating glare effects in an extremely lucid and comprehensive manner.

The problem of illumination involves three factors—a quantity factor, a quality factor, and a physiological factor. Intensity and distribution (relative intensity) linked together form the quantity factor. The independent elements diffusion and color value are combined in the quality factor. Total light flux in the field of vision and shadow contrasts are two closely related yet separate factors affecting the efficiency of the eye, the physiological factor. Subordinate to the factor of total light flux in the field of vision is the intrinsic brilliancy of light-giving or light-reflecting objects in the field of vision.

Two results are to be achieved in adequate street lighting—the avoidance of glare effect and the obtaining of an approximately uniform degree of illumination at all points along the course of the street, with higher intensities at street corners. These two results can only be obtained, the one by the correct solution of the allied problems of intrinsic brilliancy, total light flux, and shadow contrasts, the other by the correct solution of the problem of distribution.

Glare effect results whenever an amount of light falls upon the actually visualizing portion of the retina of the eye sufficient in quantity to cause chemical changes more rapidly than the regenerative functions of the eye can keep pace with. For convenience, a glare condition may be designated as casual, when it results from the inability of the pupil to adjust itself instantly to a changed condition of light intensity, and as fundamental, when it results from a light intensity exceeding the contractive power of the pupil to compensate for, or when it results from a light source near the centre of the field of vision. The presence of strong shadow contrasts tends to produce a casual condition of glare. The avoidance of objectionably located shadow contrasts can be taken care of only by the proper placement of light sources, while the intensity of the shadow contrast can be decreased by using smaller light sources placed nearer together. The problem is one which must be solved independently for each individual case. A fundamental condition of glare, with resultant heavy decrease in efficiency of vision, is produced by brilliant, high candle-power light sources in the field of vision, the usual practice in contemporary street lighting. It can

be avoided only by the proper limitation of the intrinsic brilliancy and total light flux of the light units employed. The study of the relations existing between intrinsic brilliancy and total light flux on the one hand, and glare effect on the other, becomes, therefore, one of an analysis of the illumination requirements.

The ideal to be aimed at in street lighting is uniform illumination of all points along the course of the street, with the exception of street intersections and similar crossings. The present almost universal condition of brighter illumination under and near the light unit is simply a concession to ignorance of how to obtain something better. The illumination at street intersections should be from four to eight times the intensity along the main course of the street; this, however, is merely a matter of installation. It is true within limits that in other parts of the street absolute uniformity of illumination is not required, but there is no scientific justification for a ratio of maximum to minimum intensity greater than four to one. The ratio in American practice is most frequently over 100 to one. As Dr. Bell has pointed out, the method of measuring illumination in the plane normal to the ray is responsible for a great deal of the poor light distribution in American streets. Mr. Sweet agrees with him that the measurements should always be in the horizontal plane.

Once ideal curves of light distribution to give uniform horizontal illumination are derived, the fact that absolute uniformity is not of importance, provided the ratio between maximum and minimum intensity is not greater than four to one, may be taken into account. The selection of the most desirable distribution from the infinite number which will give uniform illumination from a line of light units along a line immediately under these units will depend upon two considerations—first, that the distribution must be practicable of attainment, and, second, that the illumination at any point should be derived from a source as near as possible in order to avoid both excessively long shadows, and the glare effect which results from the high candle power necessary for illumination at great distances. Mr. Sweet discusses a number of illumination curves illustrated in his paper. The illumination curve which best meets the conditions imposed is formed by two circle quadrants. The corresponding distribution curve shows a low maximum which occurs at a slightly smaller angle than that subtended by half the separation of the units. The desired distribution curve can be easily derived from the ideal illumination curve.

The relation between any desired illumination results and the distribution required to produce these results depends upon the distance between adjacent units and the height of the light unit above the street; that is to say, for any given separation of units and height above street, we can easily calculate the distribution curve which will produce the desired illumination result. It is obvious that any given distribution curve will give the same proportionate illumination results so long as the relation between the separation of units and the height above street is kept constant, since so long as this relation remains constant, the angular relations are unchanged. Hence, for any value of the ratio between separation of units to height above street, which Mr. Sweet calls M, there is a certain distribution curve which will produce the required illumination result. In American practice the most representative value of M is 15. Mr. Sweet gives a number of polar curves of light distribution, for different values of M, intended to give uniform results. He shows that, when the light sources are separated by a distance greater than six times the mounting height above the street (that is, when M is greater than 6), it becomes impracticable to design a unit giving such light distribution as would be required for a sufficiently close approximation to uniform illumination.

Returning now to glare effect, it remains to determine the laws of operation of the conditions which produce it, and the limitations it imposes on the solution of the illumination problem. The consideration of the avoidance of glare effect will operate by imposing a definite candle-power limit at each distribution angle, this limit varying only with the

mounting height. In proportion as this candle-power limit is exceeded a greater or less glare effect will result. The net result of the limitations imposed by the avoidance of glare will be to eliminate for any given mounting height all curves of ideal distribution exceeding some definite value of *M*.

Glare effect may be assumed to vary with the following factors: (*a*) distance of the eye from the light source; (*b*) total light flux in the direction of the eye, measured in apparent candle power at the distance of the eye; (*c*) intrinsic brilliancy of the light source; (*d*) angular position of the light source in the field of vision, the visualized object being assumed to occupy the centre of the field of vision; and (*e*) distance of the light source from the eye relative to the distance of the visualized object upon which the eye is focused. Mr. Sweet has devised a method of measuring glare effect, the measure being the ratio of the two minimum light intensities on a visualized object, of magnitude just sufficient to enable its discernment, when the eye is successively exposed to the two conditions under comparison. He has made an extended research on the five factors mentioned above, which he describes in detail. We have space here merely to summarize the results, and the conclusions Mr. Sweet draws from them. At any given candle power, a considerable increase of distance produces only a small decrease in glare effect. For all ordinary distances, the presence of a light source of even a very low candle power in the field of vision causes a tremendous drop in visual efficiency. At 300 candle power, however, the glare effect has nearly reached its maximum, and beyond 300 candle power a large increase in candle power produces but a small decrease in visual efficiency. An investigation of the relation between glare effect and the angular position of the light source in the field of vision disclosed a fact of the highest importance—that at an angle varying, depending on the candle power, between approximately 22 degress and approximately 26 degrees, the glare effect reaches zero, although the light source is still well within the field of vision. This means that the light instrumental in causing glare comes entirely from the polar angles above 60 degrees. In the average actual case, glare is almost wholly caused by the light between the angles of 65 degrees and 80 degrees with the nadir. The light within these angles must be partially or wholly suppressed if glare is to be avoided.

Mr. Sweet gives a series of curves of zero glare effect for various mounting heights, with which he compares the curve of ideal distribution when *M* equals 6. It is at once apparent that this curve, together with curves of larger values of *M*, will be eliminated, on account of the serious glare effect which would result from the application of such distributions to actual practice. The curve *M* equals 4, however, comes within the limitations imposed by the curve of zero glare effect, providing the scale of the *M* equals 4 curve does not exceed that amount which would make the zero-degree candle power equal 100. The distribution curve corresponding to *M* equals 3 would come well within the limitations imposed by zero glare. For all practical purposes, 60 degrees is an absolute limit for maximum candle power if serious glare effect is to be avoided.

"In designing a light unit to give the desired distribution which has largest field of application, namely the distribution from *M* equals 4, it will be preferable by far that the candle-power values at 60 degrees and above be less than those made proper by the ideal curve, rather than that these ideal values be exceeded. With an ideal curve of such candle-power magnitude as would be most useful, the candle-power values at the angles under consideration come perilously near to the glare limit, or may even exceed the glare limit. A per cent. variation from the ideal curve of four to one is, as has been pointed out, permissible. Even a moderate condition of glare, on the other hand, is very undesirable. Practical considerations, therefore, will lead us, in the design of the actual unit, intentionally to deviate from the *M* equals 4 curve at the angles of 60 degrees and above, this deviation being in the direction of lesser candle-power values."

WASTE GASES AS FUEL FOR OPEN-HEARTH FURNACES.

THE USE OF DIFFERENT GASES FOR OPERATING OPEN-HEARTH FURNACES AND THEIR INFLUENCE ON THE QUALITY OF THE PRODUCTS.

H. Terpitz—International Mining Congress.

RECENT experiments in Germany seem likely to lead to the development of a new field for the utilization of coke-oven and blast-furnace gases. The introduction of the gas engine in steel works has released a large proportion of the waste gases which under steam operation were all required for boiler firing. The excess gases have been used with success in a number of cases for the generation of electric power for sale. It is now established, however, that they can be utilized within the works for the firing of open-hearth furnaces. The results of the German experiments were communicated to the recent International Mining Congress at Düsseldorf by H. Terpitz. The following brief summary is taken from a report in the *Iron Age* for July 14.

Special interest attaches at the present time to the utilization for operating open-hearth furnaces of the waste gases from coke ovens and of the surplus gases from blast furnaces, larger quantities of which become available as the result of the development of gas engines. For instance, 7 to 8 cubic metres of furnace gas is required per horsepower hour for a steam engine, as compared with 3 to 3½ cubic metres of furnace gas for a gas engine. At some works, as the Hörde, furnace gas has been conducted in a 3-kilometre pipe line to a distant rolling mill for firing boilers, but other works have no such outlet and must use considerable quantities of gas. At a number of places the effort has been made to take the waste blast-furnace gas to open-hearth furnaces, but the results have been disappointing on account of the low calorific value as compared with good producer gas. The most extensive experiments of the character have been carried out at the new steel works of the Georgs-Marienhütte at Osnabrück, where furnace gas alone is used for the tilting primary open-hearth furnaces. Terpitz gives it as his personal opinion that in a few years open-hearth furnaces will be operated successfully, using blast-furnace gas wholly or partly. He supports the proposals of Jos. von Ehrenwerth and Schmidhammer to regenerate blast-furnace gas by passing it through coke breeze or fine coal heated with oxygen manufactured by the Linde process.

As for the utilization of waste coke-oven gas for working open-hearth furnaces, the Hubertushütte started to do this in May, 1907. During the first calendar year the normal coal consumption was brought down by only 2.13 per cent. In 1908, however, 41.19 per cent. and in 1909, 43 per cent. of the total coal consumption was supplanted by coke-oven gas. The best results were obtained in September, 1909, when, on a production of 6,200 tons of ingots, the coal consumption amounted to only 14.9 per cent., so that 53.15 per cent. of the total requirements of coal were supplanted by coke gas. In these comparisons the basis was the average annual coal consumption of 1906, when it amounted to 318 kilogrammes per ton of ingots.

The new coke plant consists of two groups of 45 Otto-Hoffman ovens each, in which 320 tons are put through in 24 hours. The excess of gas per day is 60,000 to 70,000 cubic metres, which is not alone used for the open-hearth furnaces but also for heating the drying ovens of the foundry and for other purposes. It carries 6.5 per cent. carbonic acid, 2 per cent. of heavy hydrocarbons, 1 per cent. of oxygen, 16.4 per cent. of methane, 38.7 per cent. of hydrogen, 24.8 per cent. of nitrogen and 10.6 per cent. of carbonic oxide. The lower calorific value is about 3,300 heat units without elimination of benzol.

Terpitz ascribes the adverse effect upon the quality of the steel, which is usually attributed to the presence of hydrogen in the heating gases, entirely to mistakes in the temperature of the open-hearth heats, which may easily be made worse by mistakes in casting. He

takes similar ground as to nitrogen. As for sulphur in the heating gas, he cites some experiences and urges that the prejudices against the effect of heating gases upon the metal in the basic open-hearth process be dropped, and that attention be directed wholly to the gases which are generated in the bath itself in the oxidizing and reducing reactions. He admits a lowering in the life of furnace ports and roofs by 8 to 10 per cent., which he attributes to the increased difficulties which the employment of a higher-grade gas involves.

Since it has been shown that open-hearth furnaces may be operated with full success with waste coke-oven gas, a wide range is opened for the by-products of coke-oven plants. Since it is easier to utilize low-grade dust coal under boilers than in the producers of open-hearth furnaces, it may prove expedient in some localities to deliver the coke-oven gases rather to the open-hearth furnaces than to the boilers, and the question may arise, where gas engines are in use, whether the excess of waste coke-oven gas be more effectively used for generating power or for heating open-hearth furnaces. If there be an excess of both waste blast-furnace gas and of coke-oven gas, it will be best to utilize the coke gas for the open-hearth furnaces and the blast-furnace gas for the engines, because the higher calorific value of the former is useful for the working of the furnaces but is rather disadvantageous for driving gas engines because of the greater strains put upon the working cylinders and valve heads of the gas engines as the result of the higher temperatures. An intimate and regular mixture of gas and air is more easily attained in using blast-furnace gas for the engines, because the volumes are more nearly alike than they are with coke-oven gas with its three and one-half times higher calorific value.

THE COST OF DRIVING STEEL-WORKS BLOWING ENGINES.

A COMPARISON OF THE COST OF DRIVING BLOWING ENGINES BY STEAM ENGINES, GAS ENGINES AND ELECTRIC MOTORS.

Otto Mauritz—International Mining Congress.

THE use of gas-engine driven blowers in steel works has not kept pace with their introduction in blast-furnace plants. Blast-furnace blowing engines work under a uniform load. In steel-works operation, however, intermittent working, variations in the blast pressure and other conditions are not so well suited to the gas engine, and, notwithstanding their economy, gas-driven blowers have been introduced in comparatively few plants. There seems to be little question, however, of the superior economy of gas power for this purpose in comparison with both steam and electric power. Otto Mauritz shows, in a paper read at the recent International Mining Congress at Düsseldorf, that the difference in cost is very considerable, particularly when coal is high-priced. A brief abstract of his comparison of the costs of the three modes of driving is taken from a report in the *Iron Age* for July 14.

Until now the piston steam engine has been generally used for driving steel-works blowing engines. For new works there should be taken into consideration the use of a steam turbo-blower, while at old works even in the purchase of a blowing engine a turbo-blower would not be entertained, because it cannot compete in cost with the piston engine, usually only low superheat being available. The peculiarities of steel-works practice, frequently interrupted working and wide fluctuations in volume and pressure of blast when compared with blast-furnace blowing engines seem apparently to tell against the employment of gas engines. This accounts for the fact that so few German works have selected gas engines for driving steel-works blowing engines, although the advantage in low cost of operation is very great. A gas blowing engine is naturally operated in a different manner from a steam blowing engine. The former is not stopped during the pauses in blowing, but it is allowed to run at re-

duced speed, which involves some consumption of fuel—a loss, however, which is not larger than the loss by condensation in the pipe line of steam blowing engines during these pauses.

Herr Mauritz takes as the basis of his comparisons a steel plant with an annual production of 400,000 tons of ingots. The annual cost of running a 4,000-horse-power blowing engine is:

1. Sinking fund and interest:
   - Engine and foundations ..... 12 per cent.
   - Building ..... 6 per cent.
2. Water consumption per ton of steel ingots:
   - Steam blowing engine ..... 7.3 cubic metres = 258 cu. ft.
   - Gas-driven engine ..... 2.4 cubic metres = 85 cu. ft.
   - Electrically driven engine ..... 0.125 cubic metres = 4 cu. ft.

   1 cubic metre is reckoned to cost 1 pf. (3d. per 1,000 cubic feet).
3. Wages, lubricant, material for cleaning and maintenance, repairs, per ton of steel ingots:
   - Steam blowing engine, coal-fired boilers ..... 0.139 m. = 1.4d.
   - Steam blowing engine, gas-fired boilers ..... 0.088 m. = 0.9d.
   - Gas-driven blast engine ..... 0.88 m. = 0.9d.
   - Electrically driven ..... 0.015 m. = 0.1d.*
4. Cost of fuel or of electric current.

* This figure does not take into account the electric generating set; the cost for this is included in that for the current.

With a view to comparison on a common basis, the fuel costs are reckoned within the following limits: coal (7.5 evaporative power), 10 to 20 marks (10s. to 20s.) per ton; blast-furnace gas, 900 calories (101 B. t. u.), 0.90 to 1.80 marks (9d. to 15.8d.) per 1,000 cubic metres (35,320 cubic feet).

In valuing the blast-furnace gas, the volume of this gas taken was that equal to the weight of coal required to generate the same volume of steam. An efficiency of 75 per cent. was reckoned upon in the case of the coal-fired boilers, and an efficiency of 53 per cent. in that of the gas-fired boilers. The cost of the steam remains, therefore, the same in both cases, whether using as boiler fuel coal of 7.5 evaporative power at 10 marks per ton, or blast-furnace gas of 900 calories, at 0.90 mark per 5000 cubic metres.

The cost for electric power is more difficult to state than that for coal or blast-furnace gas; in the case of current it would be necessary to consider both whether it be produced by a steam-turbine plant (boilers either coal- or gas-fired) or in a gas-driven generating station. With a view to deal fairly also with this point, the diagrams given by Herr Mauritz apply to a current cost varying from 1.5 pf. to 3 pf. (0.15 to 0.3d.) per kilowatt-hour. This is not to be taken to imply that where coal costs 10 marks per ton, the kilowatt-hour should be valued at 1.5 pf.

The higher and the lower limits of running cost are as follows:

Type of blowing engine.	Cost: 1 ton coal at 10 m., or 1,000 cu. m. gas at 0.9 m., or 1 kw.-h. at 1.5 pf.		Cost: 1 ton coal at 20 m., or 1,000 cu. m. gas at 1.8 m., or 1 kw.-h. at 3 pf.	
	Marks.	£	Marks.	£
Steam, coal-fired boilers	268,800	= 13,440	401,000	= 20,050
Steam, gas-fired boilers	255,800	= 12,790	388,000	= 19,400
Gas-driven blowing engines	156,500	= 7,825	206,900	= 10,345
Electrically driven reciprocating blowing engines	194,500	= 9,725	344,500	= 17,225

The above comparison which applies to a new plant (case 1) shows the great superiority of gas-engine driving. The paper also considers whether a gas-driven blowing engine would be economical in cases (2) of a metallurgical works owning a steam-driven blowing engine the cost of which has been written off and (3) of a similar works whose steam-driven blowing engine is not yet written off. In the latter case, the annual provisions for sinking fund and for interest have, therefore, to be added to the annual operating cost.

The paper shows that here also the gas-driven blowing engine is the most advantageous, since the annual saving in running cost which it yields, as against a steam-driven blowing engine using gas-fired boilers, is as follows:

In case 1a. 99,300 m. = £4,965	In case a, cheapest fuel cost, 10 marks per ton.
In case 1b. 181,900 m. = £9,095	
In case 2a. 39,300 m. = £1,965	In case b, highest fuel cost, 20 marks per ton.
In case 2b. 121,900 m. = £6,095	
In case 3a. 39,300 m. = £1,965	
In case 3b. 121,900 m. = £6,095	

The savings in cases 2 and 3 are equal; the absolute cost figures vary.

Simplicity, accessibility and uniformity of the plant, that is, complete electrification, might finally lead to the putting down of an electrically-driven blowing engine (turbo-compressor), if purely economical conditions be aimed at. The conditions, however, require careful consideration for arriving at a correct solution. And when this is reached there is still to settle the point as to whether the current-generating dynamos are to be driven by gas engines or steam turbines. Under this head the author concludes that a gas-driven power station is by far the more advantageous of the two.

BRIQUETTING IRON AND STEEL CHIPS.

A PROCESS FOR UTILIZING CHIPS DEVELOPED IN GERMANY, AND ITS ECONOMIC RESULTS.

Hubert Hermanns—American Machinist.

CHIPS in many machine shops offer a problem of considerable difficulty.

In quantity they often amount to 10 per cent. of the total production of the shop. The most economical method of disposing of this refuse is to use the chips in place of other materials in furnace mixtures, but in utilizing them in this way many practical difficulties are encountered. When loose chips are charged into a furnace, part are driven out by the blast, and part are subjected to violent combustion and pass into the slag as ferric oxide. The loss amounts to as much as 50 per cent., and the large amount of viscid slag formed interferes seriously with the proper operation of the furnace. Outerbridge solved the problem by packing the chips in wooden or cast-iron boxes which he added to the charge, but the cost of this method is prohibitive except for the production of iron which can be sold at a high price. Melting down the chips in the furnace with a low blast has not given satisfactory results, nor have attempts to rust the chips together into large masses in the open air.

Trials have often been made to press the chips into briquettes with the aid of a binder. As a rule the binder has failed in the furnace heat and the briquettes have broken up. Aside from the fact that the binder itself is not an ingredient likely to improve the quality of the iron, this also resulted in a large loss in the weight of the chips by oxidation. A new and more promising process of German origin, however, is described by Hubert Hermanns in the *American Machinist* for July 7. The chips are subjected to very high pressure in a press, which compresses them into solid, compact briquettes without the use of a binder. The briquettes are used in furnace mixtures in place of scrap, with very satisfactory results as to quality of product. They are also used in the production of high-grade cast iron as a substitute for expensive grades of pig.

NUMBER 1.

30 per cent. Koldair iron, $22.80 per ton	$6.84
30 per cent. L. O. C. iron, $22.08 per ton	6.62
40 per cent. cylinder scrap, $16.80 per ton	6.72
Total cost of charge per ton.....	$20.18

NUMBER 2.

30 per cent. Frodair iron, $27.60 per ton	$8.28
20 per cent. Bearcliffe iron, $33.60 per ton	6.72
30 per cent. cylinder scrap, $15.60 per ton	4.68
20 per cent. ordinary scrap, $14.40 per ton	2.88
Total cost of charge per ton.....	$22.56

NUMBER 3.

30 per cent. Kraft I iron, $16.80 per ton	$5.04
20 per cent. briquettes of cast iron, $14.40 per ton	2.88
10 per cent. briquettes of steel, $14.40 per ton	1.44
20 per cent. Kraft III iron, $15.60 per ton	3.12
20 per cent. cylinder scrap, $15.60 per ton	3.12
Total cost of charge per ton.....	$15.60

NUMBER 4.

10 per cent. German foundry I, $16.80 per ton	$1.68
20 per cent. Lubeck 3, $15.60 per ton...	3.12
20 per cent. briquettes of cast iron, $14.40 per ton	2.88
10 per cent. briquettes of steel, $14.40 per ton	1.44
40 per cent. scrap iron, $14.40 per ton..	5.76
Total cost of charge per ton.....	$14.88

Mr. Hermanns gives a number of examples of mixtures in which chip briquettes are used in German machine works. We may quote the practice of the Borsig firm at Tegel. Before briquettes were introduced, the two principal mixtures used for high-grade cast-

ings, such as locomotive cylinders, etc., with the prices of the iron at Berlin were as in Numbers 1 and 2 above. By using the chip briquettes, similar results were obtained with the mixtures given in Numbers 3 and 4 above. Comparing the most favorable examples presented in these tables, Number 4 shows a saving of $7.68 per ton of charged material over the mixture in Number 2. Comparing the cheaper mixture without briquettes, Number 1, with the dearer briquette mixture, Number 3, there is still a saving of $4.58 per ton.

Tensile, transverse and impact tests have been made in a large German machine works on castings produced from six briquette mixtures of the following compositions:

No. 5. For machinery purposes. Briquettes, 11 per cent.; iron scrap or foundry scrap, 38 per cent. With the iron scrap omitted, 30 per cent. of briquettes is used.

No. 6. For locomotive cylinders. English and German pig with 12 per cent. briquettes and 16 per cent. cylinder scrap.

No. 7. For locomotive cylinders. German hematite and foundry pig with 18 per cent. cylinder chip briquettes and 24 per cent. cylinder scrap.

No. 8. For locomotive cylinders. German high-manganese pig and foundry pig with 24 per cent. cylinder chip briquettes and 34 per cent. cylinder scrap.

No. 9. For steam cylinders. Special grades of pig with 12 per cent. cast-iron chip briquettes.

No. 10. For compressor covers. Special grades of cast iron with 18 per cent. ordinary briquettes and 8 per cent. wrought iron refuse.

The tensile tests were made on 1-inch bars. The transverse test bars were 1 9/16 inches square; their length between supports was 36 inches. For the impact tests, bars 10 inches long were planed to 1½ inches square. They were laid on two knife edges 6¼ inches apart, and subjected to a blow from a 26½-pound weight, begun with a drop of 13 inches and increased by about 2 inches at each stroke. The increase in strength through the addition of briquettes to mixture No. 5 is shown in Table 1. The strengths of the cast irons produced from the other mixtures are given in Table 2. The results would seem to indicate that considerable increase in the strength of castings is to be obtained by the use of briquettes.

The results of another series of tests reported by Mr. Hermanns show that "the effect of the briquettes in the charge is essentially to increase the tensile and transverse strength by reducing the quantity of carbon. Because of their compact mass, as compared with loose chips, the briquettes are protected from strong oxidation in the upper melting zones and against slagging, and in comparison with pig iron they have a more or less porous structure. Thus part of the graphitic carbon present in the briquette is consumed above the melting zone. An enrichment with carbon may take place during the melting, but this does not suffice to make up completely for the carbon that has been lost, and the results are a considerable lessening of the total carbon contained.

TABLE 1.

Test.	Pounds per square inch. Without briquettes.	With briquettes. 20 per cent.	30 per cent.
Tensile strength	...25,000 to 28,000	32,200 33,200	41,300 42,400
Transverse strength	...37,500 to 47,000	50,600	53,500
	Height of drop in inches.		
Impact	13 to 16	20	22

TABLE 2.

Number of Mixture.	Tensile. Transverse. Pounds per square inch.		Impact. Drop in inches.
6	37,500	56,500	27.5
6	35,200	55,400	20.0
7	45,700	77,700	25.5
7	48,500	76,000	39.4
8	48,400	78,500	27.5
8	45,700	67,500	29.5
9	35,200	55,400	20.0
9	37,500	56,500	27.5
10	38,700	66,800	25.5
10	39,100	70,000	27.5

"In steel foundries chip briquettes may serve as a substitute for the low-phosphorus white iron that is largely used. In fact, they can be used economically in any place where steel scrap is used, whether it be in the foundry or the steel mill, as briquettes of steel or wrought-iron chips are a good charging material. . . . Chips from hard rolls, projectiles, etc., may be so mixed with gray-iron chips as to make a uniform charging material. Chips from copper, brass, bronze, white metal, etc., have also been briquetted and a saving effected. This is due to the fact that the cost of pressing the chips into briquettes is much less than the savings that are effected in many other ways, such as in the lesser oxidation of the metal in remelting, the easier methods employed in handling the chips, and the less space required for storage."

THE ENGINEERING INDEX

"THE KEYSTONE IN THE ARCH OF APPLIED SCIENCE"

The following pages form a *descriptive* index to the leading and special articles of permanent value published currently in the Transactions of all the important engineering societies of both Europe and America, and in all the leading engineering journals of the world—in the English, French, German, Dutch, Italian, and Spanish languages.

The term *descriptive* is used because the definite purpose of each index note is to indicate clearly the character and purpose of the article or paper described; and with that in view we give the following essential information about every publication:

(1) The title of the article,
(2) The name of its author,
(3) A descriptive abstract,
(4) Its length in words,
(5) Where published,
(6) When published,
(7) *We supply the article itself, if desired.*

☞ The full text of every article described in the Index, together with all its illustrations, can usually be supplied by us.—See the "Explanatory Note" at the end of the Index, where also the full titles of the principal journals indexed are given.

NOTE—The busy engineer will also observe that the Index is conveniently classified into the larger divisions of engineering science, to the end that the reader may quickly turn to what concerns himself and his special branches of work. By this means it is possible, within a few minutes' time each month, to learn promptly of every important article published anywhere in the world, in any language, upon the subjects claiming one's special interest.

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CIVIL ENGINEERING.

BRIDGES.

American.

Notes on Recent American Bridges. Brief descriptions of examples of recent work. 2500 w. Engr, Lond—June 24, 1910. No. 15553 A.

Arches.

The Design of Three-Hinge Arches (Beitrag zur Dimensionierung von Dreigelenkbögen). H. Maier. Mathematical. 1500 w. Deutsche Bau—June 15, 1910. No. 15906 B.

Graphical Solution of the Continuous Arch (Le Calcul graphique de l'Arc continu). Louis Schaffner. A detailed mathematical demonstration of the method. Ills. Serial. 1st part. 4000 w. Génie Civil—June 4, 1910. No. 15734 D.

Graphical Determination of the Abutment Reactions of a Fixed-End Arch with Parabolic Axis, Constant Section and Supports of Equal Height (Graphische Bestimmung der Kämpfer-Reaktionen für einen Gewölbebogen—beiderseits einge-

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spannt—mit parabolischer Achse, konstantem Querschnitte und gleicher Höhenlage der Kämpfer). Mathematical. Ills. 1000 w. Zeitschr d Oest Ing u Arch Ver—June 24, 1910. No. 15929 D.

The Fixed-End Arch with Two Intermediate Hinges (Der beiderseits eingespannte Bogenträger mit zwei Zwischengeleken). Cajetan Holik. An exhaustive mathematical discussion. Ills. Serial. 1st part. 4500 w. Oest Wochenschr f d Oeffent Baudienst—June 25, 1910. No. 15932 D.

Culverts.

Methods and Cost of Constructing Concrete Arch and Cast Iron Pipe Culverts by Day Labor, Illinois and Mississippi Canal. Report of the work. 2000 w. Engng. Con—June 29, 1910. No. 15332.

Erection.

The Erection of the Dumbarton Point Bridge. The erection of the superstructure of a bridge on the So. Pacific across the lower end of San Francisco Bay is illustrated and described. 1200 w. Eng Rec—July 23, 1910. No. 15886.

Perilous Bridge Erection. An illustrated account of methods and risks taken in the erection of the Miles glacier bridge, Alaska. Also Editorial. 2800 w. Eng Rec—July 16, 1910. No. 15634.

Foundations.

Substructure of a Double-Track Railroad Bridge at Peoria. Illustrates and describes a substructure of concrete piers and abutments founded on timber piles driven to rock. 2000 w. Eng Rec—July 23, 1910. No. 15884.

Masonry.

The Two Highest Masonry Bridges in the World. F. Honoré. Illustrations and brief notes on the Constantine bridge in Algeria, and the bridge at Ronda, Spain. 350 w. Sci Am—July 9, 1910. No. 15413.

Piers.

See also Foundations, under BRIDGES.

Quebec.

Quebec Bridge Substructure. Illustrated article dealing with the new substructure, its difficulties and construction methods. 1200 w. Can Engr—July 14, 1910. No. 15636.

Reconstruction.

Reconstructing a Defective Bridge Under Traffic. Brief illustrated description of methods used in reconstructing the Boves bridge, Northern Railway (France). 600 w. Eng News—June 30, 1910. No. 15399.

See also Bridges, under RAILWAY ENGINEERING, PERMANENT WAY AND BUILDINGS.

Reinforced Concrete.

The Seventh Street Bridge, Los Angeles, California. Illustrated description of a reinforced-concrete structure of three 80-ft. spans, and having a total length of 318.24 ft. 2000 w. Eng Rec—July 2, 1910. No. 15387.

Reinforced Concrete Bridge at Los Angeles, California. Edward P. Bailey. Brief illustrated description of a novel tower and flume method of distributing concrete, and other features of the construction. 500 w. Munic Jour & Engr—July 13, 1910. No. 15605.

The Reinforced Concrete Bridge over the Iser at Sojowitz (Die Eisenbetonbrücke über den Iserfluss in Sojowitz). Stan. Spacek. Describes a four-span girder bridge. Ills. 3000 w. Oest Wochenschr f d Oeffent Baudienst—June 11, 1910. No. 15930 D.

Restoration.

Restoration of the Auld Brig O'Ayr. Illustrated description of very interesting work for the preservation of an historical structure in Scotland. 4000 w. Engng—July 15, 1910. No. 15970 A.

Steel.

The Mississippi River Bridge at St. Louis for the Illinois Electric Traction System. Illustrated detailed description of this important engineering structure and its erection. 5500 w. Eng News—July 28, 1910. No. 16024.

Double Track Truss Bridge with Suspended Tracks. Illustrated description of an interesting structure at Conneaut Harbor, Ohio, now under construction. 300 w. Ry Age Gaz—July 8, 1910. No. 15469.

The Hudson River Bridge at Waterford, N. Y. Brief illustrated description of the old Burr-truss bridge, destroyed by fire July 10, 1909, and the new steel truss superstructure placed on the old piers. 1000 w. Eng News—July 14, 1910. No. 15588.

Swing Bridges.

The Langebro Harbor Bridge, Copenhagen. Plate and description of the construction of a swing-bridge in Denmark, having elaborate hydraulic machinery, and unusual features. 8500 w. Engng—June 10, 1910. Serial. 1st part. No. 15497 A.

Viaducts.

Portcreek Viaduct. A substantial wrought-iron and steel structure, replacing a timber viaduct, is illustrated and described. 600 w. Engr, Lond—June 24, 1910. No. 15552 A.

The Design and Construction of the Paulin's Kill Viaduct. Illustrated description of this reinforced-concrete structure which carries the new double-track cut-off of the D., L. & W. R. R. across the Paulin's Kill valley. 2500 w. Eng Rec—July 16, 1910. No. 15627.

A Notable Bridge. Brief illustrated description of the Assopos viaduct on the Piraeus Railway, Greece, and its erection. 1000 w. Sci Am Sup—July 2, 1910. No. 15403.

The Gorgopotamos Viaduct, Greece (Le Viaduc du Gorgopotamos, Grèce). Georges Bodin. Describes an important steel structure on the Grecian Railway.

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Ills. 2000 w. Génie Civil—June 18, 1910. No. 15737 D.

Elevated Street Crossing at the Kieritzsch Station (Strassenüberführung auf Bahnhof Kieritzsch). Em. Haimovici. Detailed description of a short reinforced concrete viaduct. Ills. 2500 w. Beton u Eisen—June 10, 1910. No. 15933 F.

CONSTRUCTION.

Architecture.

Architectural Treatment of Engineering Structures (Ingenieurarchitekturen). W. Franz. A plea for the aesthetic treatment of engineering structures. Ills. 2000 w. Tech u Wirt—June, 1910. No. 15958 D.

Columns.

See Reinforced Concrete, under MATERIALS OF CONSTRUCTION.

Concrete.

Notes on Concrete Construction. Robert A. Cummings. Discusses the relation of construction to design, methods of construction, etc., illustrating and describing work. Short discussion. 7000 w. Pro Engrs' Soc of W Penn—June 1910. No. 15817 D.

The Construction of Concrete Fence Posts. Considers the comparative advantages of concrete and wooden posts, the materials for making concrete, methods, etc. Ills. 8500 w. U S Dept of Agri, Bul. 403—May 21, 1910. No. 16006 N.

European Concrete and Stucco Work. Rolf R. Newman. Descriptive notes and photographs taken during the summer of 1909. 3000 w. Cement Age—July, 1910. No. 15812.

Novel Uses of Concrete in One of California's Largest Wine Plants. Horatio F. Stoll. Illustrates and describes uses at the Italian-Swiss Colony's dry wine vineyard and winery at Asti. 1500 w. Cement Age—July, 1910. No. 15811.

An Experiment to Determine the Pressure of Concrete Upon Forms. L. E. Ashley. Describes apparatus used in a test made at the University of Illinois, giving results. 800 w. Eng News—June 30, 1910. No. 15398.

Earth Pressures.

Bracing and Sheeting Trenches. Frank H. Carter. Explains the writer's methods and practice in computing pressures on bracing and shoring. 1200 w. Engng-Con—July 27, 1910. No. 16016.

Earthwork.

Methods and Cost of Steam Shovel Work Loading Slag, Earth, and Sand into Cars for Railway Ballasting and Grading. D. A. Wallace. 800 w. Engng-Con—July 27, 1910. No. 16015.

Methods of Making Deep Fills by Suspending Track from Cableway. Discussion, by F. E. Cudworth and Daniel J. Hauer, on schemes for embankment construction. 3000 w. Engng-Con—July 20, 1910. No. 15690.

Excavation.

See Rock Removal, under WATERWAYS AND HARBORS.

Excavators.

A Giant Steam Excavator. Illustrates and describes a new type of steam crane excavator invented by A. R. Grossmith. 2000 w. Sci Am—July 9, 1910. No. 15412.

Floors.

Hollow-Tile Floor Construction without Girders (Nouveau Plancher à Briques creuses sans Poutres). H. Deniau. A brief description of the new Faber system. Ills. Serial. 1st part. 1500 w. Rev Indus—June 25, 1910. No. 15731 D.

Foundations.

Testing Soil Below the Surface for Foundation Loads. Illustrates and describes methods used to investigate the bearing capacity of the soil at a considerable depth below curb. 1200 w. Eng Rec—July 16, 1910. No. 15629.

Foundation Work on the Municipal Building, New York. Information concerning changes agreed upon in connection with the foundation work for a $11,000,000 building in the Brooklyn Bridge plaza. Diagrams. 2500 w. Eng Rec—July 9, 1910. No. 15455.

A Municipal Building of the City of New York. Illustration and interesting facts concerning the $10,000,000 building under construction near the terminus of the Brooklyn Bridge. It has the deepest foundations in the world—144 feet below curb. 1500 w. Sci Am—July 16, 1910. No. 15508.

Pile Cutting.

A Machine for Cutting Off Submerged Piles to Exact Elevation. From a paper by Clarence Coleman. Illustrated description of the device. 1000 w. Engng-Con—June 29, 1910. No. 15335.

Piling.

Failure of Concrete Piles Under Ocean Pier at Long Beach, Cal. L. A. Waterbury. Brief account, with illustration, and editorial note. 1000 w. Eng News—July 21, 1910. No. 15803.

Regulations.

Criticism of the Standards of Reinforced-Concrete Construction of Various Countries (Critica delle Norme vigenti per le Costruzioni di Cemento armato nei vari Stati). Deals with the regulations in force in the principal countries of Europe. 4000 w. Il Cemento—June 30, 1910. No. 15758 D.

Reinforced Concrete.

Graphical Design of Reinforced Concrete Structures (Graphostatische Berechnung von Konstruktionen aus Eisenbeton). K. Bakker. Mathematical discussion of bending and axial loads. Ills. 2000 w. Beton u Eisen—June 10, 1910. No. 15935 F.

Retaining Walls.

Comparative Sections of Thirty Retaining Walls and Some Notes on Retaining

We supply copies of these articles. See page 966.

Wall Design. Frank H. Carter. Diagrams. 1200 w. Eng News—July 28, 1910. No. 16030.

Steel.

A New Method of Proportioning Webs and Stiffeners in Plate Girders. H. M. Gibb. A mathematical determination, illustrated by a special case. 2000 w. Engng—July 8, 1910. No. 15671 A.

The Design of Riveted Brackets. W. T. S. Butlin. Refers to an article by Munroe R. Hall in *Eng. News*, showing the limitation of the method, and that a formula may be obtained having the widest application. 1800 w. Engr, Lond—July 8, 1910. No. 15679 A.

General Features of the Curtis Building, Philadelphia. A fireproof steel cage structure occupying a city block and having a height of ten full stories, designed for the requirements of a large publishing business. Ills. 4500 w. Eng Rec—July 9, 1910. No. 15454.

Erection of the Curtis Building, Philadelphia. Illutsrates and describes erection methods of interest because of their magnitude, the conditions, rapid work, and carefully planned details. 2500 w. Eng Rec—July 16, 1910. No. 15630.

The Extension of the Columbia Building, New York. Describes methods used in adding three additional stories to a 12-story building, without disturbing tenants. 1800 w. Eng Rec—July 23, 1910. No. 15881.

Theatres.

The Shea Theatre from an Engineering Point of View. A. C. Oxley. Detailed description of fireproof construction of a theatre building in Toronto, Canada. Ills. 2500 w. Can Engr—July 7, 1910. No. 15489.

Trenches.

See Earth Pressures, under CONSTRUCTION.

Tunnel Lining.

Method and Cost of Constructing a Concrete Tunnel Lining with an 80-Ft. Gravity Chute. W. D'Rohan. Report of work in connection with irrigation in Colorado. 1500 w. Engng-Con—July 6, 1910. No. 15492.

Tunnels.

Reconstruction of the Washington St. Tunnel Under the Chicago River. Illustrated description of unusual tunnel work, explaining conditions. 4500 w. Eng News—July 21, 1910. No. 15806.

The Laramie-Poudre Tunnel. An account of the progress on this tunnel in Colorado which will bring the waters from the Laramie River into the Cache La Poudre River for irrigation. 1500 w. Eng Rec—July 2, 1910. No. 15388.

The Paris Metropolitan Railway. Illustrated detailed description of the exceptionally difficult work of forming the tunnels under the two branches of the Seine. Based on an article in *Le Génie Civil*. 2000 w. Engr, Lond—July 1, 1910. No. 15557 A.

Tunnelling Under the Seine by the Freezing Process. Illustrated description of interesting engineering work in the construction of the Paris Metropolitan Ry., near St. Michel Station. 1500 w. Builder—June 25, 1910. No. 15502 A.

The Construction of the Lötschberg Tunnel (I Lavori al Tunnel del Lötschberg). A detailed report of progress by months and by quarters since April 1, 1909. 4200 w. Monit Tech—June 30, 1910. No. 15754 D.

Underpinning.

Underpinning the Astor Building, New York. Describes underpinning a 7- and 8-story building in New York, during the construction of foundations for an adjoining 42-story building. 2000 w. Eng Rec—July 2, 1910. No. 15390.

Wage Systems.

Experience with Day Labor Work in the Maintenance and Repairs of Bridges in Chicago, Ill. Information from the recent report of Chicago Commission on City Expenditures. 5000 w. Engng-Con—June 29, 1910. No. 15334.

MATERIALS OF CONSTRUCTION.

Cement.

The Effect of Sea Water, Alkali Water, and Sewage on Portland Cement and Methods Used for Counteracting Same. W. D'Rohan. Reviews the theories advanced to account for the destruction, the causes, and the remedies. 5000 w. Engng-Con—July 20, 1910. No. 15689.

Recent Investigations on the Constitution of Portland Cement. Clifford Richardson. Describes the origin and method of production, the structure and constitution. 3500 w. Eng Rec—July 16, 1910. No. 15632.

Concrete.

The Effect of Sodium Silicate on Concrete. Albert Moyer. Read before the Am. Soc. for Test. Mat. Gives results of experiemnts. 1500 w. Eng Rec—July 23, 1910. No. 15883.

Long-Time Tests on Concrete in Sea Water. A. Poulsen. Report presented to the Fifth Congress of the Int. Assn. for Test. Mat. 2000 w. Eng News—July 7, 1910. No. 15407.

See also Aqueducts, under WATER SUPPLY.

Paints.

Exposure Tests of Structural Steel Coatings. Cloyd M. Chapman. Read before the Am. Soc. for Test. Mat. Describes tests and reports ratings of 530 different paints after one- and two-year terms of service. Ills. 2000 w. Ir Age—July 14, 1910. No. 15508.

Reinforced Concrete.

Repeated and Eccentric Load Tests of Reinforced-Concrete Columns. M. O.

Withey. Read before the Am. Soc. for Test. Mat. Reports results of tests made on some very strong spirally reinforced columns at the University of Wisconsin. 2500 w. Eng Rec—July 9, 1910. No. 15458.

Steel.

The Condition of the Steel of the Gillender Building; A Preliminary Report. Maximilian Toch. A statement of the condition of the framework of a 14-year-old building, now being removed, which is reassuring. Ills. 800 w. Eng News—July 14, 1910. No. 15595.

Strength of Steel in I-Beams. E. L. Hancock. Read before the Am. Soc. for Test. Mat. Micrographs and report of tests. 1500 w. Eng Rec—July 9, 1910. No. 15456.

Stucco.

Cement Stucco. Albert Moyer. Suggestions for the successful use of this material. 2000 w. Munic Engng—July, 1910. No. 15850 C.

Timber.

Lumber. F. R. Babcock. Considers the sources, cutting, grading, curing, etc. Discussion. 4500 w. Pro Engrs' Soc of W Penn—June, 1910. No. 15818 D.

Tests of Timber Beams. Arthur N. Talbot. A report of methods of testing, giving experimental data and discussion. Ills. 15000 w. Univ of Ill, Bul 41—Dec. 12, 1909. No. 15815 N.

Timber Preservation.

Wood Preservation from an Engineering Standpoint. C. T. Barnum. Discusses preservatives, treating processes, length of life, and economic considerations. General discussion. 10000 w. Jour W Soc of Engrs—June, 1910. No. 15855 D.

Creosote for Wood Blocks. Richard Lamb. Plea for use of standard dead oil of coal tar. 1200 w. Munic Jour & Engr—July 6, 1910. No. 15420.

Preservation of Wooden Poles by Impregnation with Fluorides (Konservierung hölzerner Leitungsmaste durch Tränkung mit Fluoriden). Robert Nowotny. Describes the zinc-fluoride process of timber preservation and gives results Ills. 3600 w. Elektrotech u Maschinenbau—June 12, 1910. No. 15943 D.

MEASUREMENT.

Bituminous-Materials Testing.

An Instrument for Ascertaining the Tenacity and Ductility of Bituminous Materials. Herbert Abraham. Read before the Am. Soc. for Test. Mat. Illustrates and describes an improved instrument. 1800 w. Engng-Con—July 20, 1910. No. 15691.

The Determination of Soluble Bitumen. Provost Hubbard and C. S. Reeve. Paper before the Am. Soc. for Test. Mat. A report of investigations and methods used, giving results. 3000 w. Engng-Con—July 6 1910. No. 15493.

Proposed Standard Tests for Road Materials of the American Society for Testing Materials. 2000 w. Engng-Con—July 20, 1910. No. 15692.

Surveying.

Methods and Costs of Midwinter Surveying; The St. Louis and Cloquet River Surveys, Minnesota. C. R. Adams. Information concerning surveys in Minnesota to investigate the water resources. Ills. 2200 w. Eng News—July 28, 1910. No. 16028.

MUNICIPAL.

Pavements.

See Timber Preservation, under MATERIALS OF CONSTRUCTION.

Philippines.

District Engineer Work in the Philippines. William Goldsmith. An account of the good-road work and its benefits, the government buildings, culverts, bridges, etc. Ills. 2000 w. Eng News—July 7, 1910. No. 15406.

Power Plants.

Motive Powers for Municipal Engineers. Arthur E. Collins. Read before the Incor. Assn. of Munic. & Co. Engrs. Discusses various methods of obtaining motive power for water supply, sewage pumping, workshop driving, and other purposes. 4000 w. Surveyor—July 1, 1910. Serial. 1st part. No. 15528 A.

Public Baths.

The Vienna Municipal Baths (Die städtischen Volksbäder in Wien). Franz Wejmola. Describes their construction and administration. Ills. 3500 w. Zeitschr d Oest Ing u Arch Ver—June 24, 1910. No. 15928 D.

Refuse Disposal.

Town Scavenging and Refuse Disposal. Hugh S. Watson. On the utilization of residuals from refuse destructors. 2500 w. Munic Engng—July, 1910. No. 15848 C.

The Design and Working of a Modern Refuse Destructor. William F. Loveday. Abstract of paper read before the Incor. Assn. of Munic. & Co. Engrs. A review of types and the methods of operating. 2500 w. Mech Engr—July 8, 1910. No. 15666 A.

Chicago Waste Disposal System. Illustrated description of the disposal station which receives the wastes and loads the material on scows for transportation to places where it is used for reclamation purposes. 1800 w. Eng Rec—July 2, 1910. No. 15386.

Milwaukee Incinerating Plant. Describes method of testing this important plant. 2000 w. Munic Jour & Engr—June 29, 1910. No. 15309.

The Construction and Testing of the Milwaukee Refuse Incinerator. Samuel A. Greeley. Describes the design, construction and tests of a new incinerator which promises success. Ills. 7000 w. Eng News—July 21, 1910. No. 15802.

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Tests of the Milwaukee Refuse Destructor. Illustrates and describes one of the largest plants of the kind in the United States, reporting the satisfactory tests. 3000 w. Eng Rec—July 16, 1910. No. 15625.

Westmount Incinerator and Power Plant. George W. Thompson. Describes the use of refuse destructors for generating electric light and power for this city in Quebec, Canada. 2500 w. Can Elec News—July, 1910. No. 15448.

Road Rollers.

The Management and Care of Steam Road-Rollers. Wilfred Eddison. Suggestions. 1800 w. Surveyor—July 8, 1910. Serial. 1st part. No. 15664 A.

A Road Roller of Improved Design with Novel Form of Front Truck. Illustrated description of the Geiser road roller, explaining its advantages. 2500 w. Eng News—July 7, 1910. No. 15408.

Roads.

Dynamic Relations between Wheel and Road (Relations dynamiques entre la Voiture et la Route). A. Petot. A study of the effect of automobiles on roads. Ills. Serial. 1st part. 4500 w. Tech Mod—June, 1910. No. 15723 D.

Roads and Automobile Traffic in Italy (Le Strade e l'Automobilismo in Italia). Domenico Ruggeri. Discusses road construction and maintenance, and the use of automobiles for public service. Ills. 6500 w. Ann d Soc d Ing e d Arch Ital—June 1, 1910. No. 15748 F.

The Value of Rise-and-Fall Elimination on Streets and Roads. Editorial on the cost of rise-and-fall in street and road improvements and the gain from the elimination. 2500 w. Eng News—July 14, 1910. No. 15593.

Improved Highways in Fulton County Georgia. William H. Stone. Illustrated description of work in the construction of improved roads. 1500 w. Mfrs' Rec—July 7, 1910. No. 15394.

Highway Construction in Cuba. From a paper by Mason M. Patrick, in *Prof. Mem.* Describes the construction of four roads in the Province of Pinar del Rio. 6000 w. Engng-Con—July 27, 1910. No. 16017.

Progress Reports of Experiments in Dust Prevention and Road Preservation. Logan Waller Page. Describes experiments and reports results obtained. 12500 w. U S Dept of Agri—Circular 92. No. 15985 N.

Experiments of the State Highway Department of Ohio with Various Road Binding Materials. Describes experiments made on a road near Columbus, Ohio. 5000 w. Engng-Con—July 6, 1910. No. 15494.

Tar for Road Works. R. O. Wynne-Roberts. Discusses methods of production, and their effect on the quality. 3000 w. Surveyor—July 1, 1910. Serial. 1st part. No. 15527 A.

Sewage Disposal.

Modern Biological Sewage Treatment. W. J. Dibdin. Presidential address delivered before the Assn. of Mgrs. of Sewage Disposal Works at Northampton, Eng. 2000 w. Surveyor—July 8, 1910. Serial. 1st part. No. 15665 A.

Rapid Sewage Sedimentation. Emil Kuichling. Abstract of experimental investigations on the sedimentation of sewage at Cologne, Germany, made by City Engineer Steuernagel. 2500 w. Munic Jour & Engr—July 20, 1910. No. 15820.

The Calumet-Sag Channel of the Chicago Drainage Canal Recommended as the Best Means of Sewage Disposal for the Calumet District. Gives a report submitted on the question of disposing of the sewage of this district of Chicago. 2000 w. Engng-Con—June 29, 1910. No. 15333.

Septic Tank and Contact Beds for Treating the Sewage of Cherryvale, Kan. J. S. Worley. States the conditions and gives an illustrated description of the contact beds for treating effluent from septic tank. 1500 w. Eng News—June 30, 1910. No. 15397.

Sewage Disposal for a School Building. O. B. Craig. Directions for building a combined septic tank and filter bed, explaining the purification process. Ills. 2500 w. Met Work—July 23, 1910. No. 15863.

A Septic Tank for Isolated Houses (Fosse septique pour Habitations isolées). Describes a simple system of sewage disposal for isolated houses or small communities. Ills. 2000 w. Génie Civil—June 25, 1910. No. 15741 D.

Sewage Pumping.

See Sewers, under MUNICIPAL.

Sewers.

New Sewers and Sewage Pumps at Richmond. Explains conditions, and gives illustrated description of the new sewage and pumping station. 2000 w. Engr, Lond—July 8, 1910. Serial. 1st part. No. 15682 A.

Difficult Sewer Reconstruction. Illustrates and describes methods used in replacing a sewer in Duane Street, New York City, made necessary by the construction of the Bridge Loop subway. 2500 w. Eng Rec—July 9, 1910. No. 15459.

Street Cleaning.

Modern Methods of Street Cleaning. George A. Soper. Portions of an address before the first New England Conference on Street Cleaning. 1500 w. Eng News—July 28, 1910. No. 16027.

New York Street Cleaning. Illustrates and describes the methods and extent of the work and the disposal of refuse. 4500 w. Munic Jour & Engr—July 13, 1910. No. 15604.

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WATER SUPPLY.

Aqueducts.

Further Tests of Models of the Medina Aqueduct Arch. Illustrated general description of the second series of tests, giving results. 1800 w. Eng Rec—July 9, 1910. No. 15450.

Second Series of Concrete Model-Arch Tests for Medina Aqueduct, New York State Barge Canal. Gives results of these tests. Ills. 1200 w. Eng News—July 7, 1910. No. 15410.

The Owens Valley and Olancha Divisions of the Los Angeles Aqueduct. Illustrates and describes the construction methods used for the open canal sections of this work, having a length of 60 miles. 3300 w. Eng Rec—July 2, 1910. No. 15389.

Electricity in the Construction of the Los Angeles Aqueduct. Illustrated description of the power system, and the applications of electricity. 3000 w. Eng Rec—July 16, 1910. No. 15633.

A New Aqueduct for Genoa (Per un nuovo Acquedotto a Servizio della Citta di Genova). Describes a project for increasing the water supply of Genoa. Ills. 3000 w. Monit Tech—May 30, 1910. No. 15749 D.

Some Roman Hydraulic Works (Di alcune Opere idrauliche Romane). G. de Angelis d'Ossat. Describes and discusses Roman aqueducts and conduits. Ills. 5000 w. Ann d Soc d Ing e d Arch Ital—May 15, 1910. No. 15747 F.

Conduits.

A Reinforced-Concrete Conduit Operating Under a Head. Explains conditions at Salt Lake City, Utah, and gives illustrated description of the method of building a circular conduit. 1800 w. Eng Rec—July 23, 1910. No. 15885.

The New Cast-Iron Conduit of the Syracuse Water Works. Illustrated description of a line 19 miles long recently laid between Skaneatles Lake and Woodland reservoir; made necessary by the growth of the city. 3500 w. Eng Rec—July 2, 1910. No. 15392.

Dams.

British Views Regarding Earth Dams. Abstract of a paper by George N. Yourdi, before the British Assn. of Water Engrs. Also of discussion. 2000 w. Eng Rec—July 9, 1910. No. 15457.

The Shoshone Dam of the United States Reclamation Service. D. W. Cole. Map and illustrated detailed description of the method of constructing the highest dam in the world, on the Shoshone River, Wyoming. Plate. 7800 w. Eng Rec—July 23, 1910. No. 15878.

The Chaudiere Dam, Ottawa, Canada. Douglas L. McLean. Illustrates and describes an interesting type of stop-log dam on the Ottawa River. It is of steel and concrete construction and of the pier-and-sluice type. 2200 w. Eng News—June 30, 1910. No. 15395.

Methods and Cost of Constructing Concrete Core Wall in Moline Pool Dam in Mississippi River at Moline, Ill. J. B. Bassett, in *Prof. Mem.*, Engineer School, Washington, D. C. Illustrated description of methods and statement of cost. 1700 w. Engng-Con—July 27, 1910. No. 16014.

Replacement of Timber with Reinforced-Concrete Sills in the Chanoine Navigation Passages of the Moveable Dams of the Upper Seine (Remplacement des Seuils en Bois des Passes navigables—du Système Chanoine—de la Haute-Seine par des Seuils en Béton armé). M. Imbs. Describes methods and cost of the work. Ills. 3000 w. Ann d Ponts et Chaussées—1910—III. No. 15743 E + F.

Disinfection.

Hypochlorite Disinfection of the Water-Supply of Toronto, Ont. T. Aird Murray. Information relating to the reduction of bacteria and the total elimination of intestinal bacteria, by the temporary use of hypochlorite as a disinfectant. 1200 w. Eng News—July 21, 1910. No. 15805.

Filtration.

A Mechanical Filter for the Removal of Iron. A plant in Iowa City, Ia., for the removal of iron by precipitation with lime and subsequent mechanical filtration, is illustrated and described. 1800 w. Eng Rec—July 23, 1910. No. 15882.

Fire Protection.

High-Pressure Fire Protection System at Oakland, Cal. Illustrated description of the salt water, high-pressure, fire protection system recently put in operation. 3500 w. Eng Rec—July 23, 1910. No. 15880.

Genoa.

See Aqueducts, under WATER SUPPLY.

Havana.

Notes on the Water-Supply of Havana, Cuba. R. Winthrop Pratt. Brief illustrated description of the antique filter plant and the present water supply system. 1200 w. Eng News—July 14, 1910. No. 15591.

Illinois.

The Quality of the Surface Waters of Illinois. W. D. Collins. Report of investigations made, furnishing means of stating the quality of the water which may be found at any point along the larger streams within or bordering the State. Map. 27000 w. U S Geol Survey—Paper 239. No. 15285 N.

Irrigation.

Irrigation and Electrical Energy. Illustrates and describes the hydroelectric features of some of the projects of the reclamation service in the United States. 2000 w. Elec Wld—July 7, 1910. No. 15481.

The Relative Value of Irrigating Waters. Herman Stabler. A discussion of

the alkali problem, giving tables and information based on irrigation practice in the United States. 1800 w. Eng News—July 14, 1910. No. 15597.

Irrigation in Siam (Mededeelingen betreffende de Werkzaamheden bij het Irrigatie-Departement in Siam). J. van Tubergen. Describes recent developments. 8000 w. De Ingenieur—June 4, 1910. No. 15964 D.

See also Electric Pumping, under MECHANICAL ENGINEERING, HYDRAULICS.

Pipe Flow.

Flow of Water in Curved Pipes. John Eustice. Read before the Roy. Soc. An account of investigations to determine the variation in the resistance to the flow of water in pipes due to the curvature. 2500 w. Engr, Lond—July 1, 1910. No. 15567 A.

Pipe Lines.

Allievi's Theory of Pressure Variations in Pipe Lines (Bemerkungen zur Alievischen Theorie der Druckschwankungen in Rohrleitungen). E. Braun. Mathematical and graphical presentation. Ills. Serial. 1st part. 1700 w. Die Turbine—June 20, 1910. No. 15909 D.

The Pipe Lines of the Kinloch-Leven Hydroelectric Plant (Die Rohrleitungen der hydroelektrischen Anlage Kinloch-Leven). E. Liersch. Detailed description of the design and construction. Ills. 4200 w. Zeitschr d Ver Deutscher Ing—June 27, 1910. No. 15947 D.

Reservoirs.

Making a Stream Excavate Its Own Reservoir and Build Its Own Dam. Burt A. Heinly. Describes methods of constructing which have become popular in the West. Ills. 1000 w. Munic Engng—July, 1910. No. 15849 C.

Siphons.

Reinforced-Concrete Siphon for a 65-Foot Head. Illustrated description of siphons built in connection with the Los Angeles Aqueduct. 1600 w. Eng Rec—July 9, 1910. No. 15453.

Sterilization.

The Ultra-Violet Rays and Their Industrial Application to the Sterilization of Water and other Liquids (Les Rayons ultra-violet et leur Application industrielle à la Stérilisation des Eaux et autres Liquides). Dr. Nogier. A review of the process and its practical application. 6000 w. Tech Mod—June, 1910. (Sup.) No. 15720 D.

Stream Discharge.

Discharges of Glacial Streams (Considérations sur les Débits industriels des Cours d'Eau de Régime glaciaire). A. Boucher and H. Chenaud. Gives charts showing variations in discharge from year to year of streams fed by glaciers. 1200 w. Bul Tech d l Suisse Rom—June 10, 1910. No. 15729 D.

Stream Flow.

What Stream Gagings Indicate as to the Run-Off from Forested and Barren Areas. A letter from Farley Gannett, on the relations between deforestation and stream flow. 2500 w. Eng News—June 30, 1910. No. 15401.

Tanks.

Weights of Cylindrical Pressure Tanks. C. R. Whittier. Tables, diagram, and method of calculating. 1000 w. Mach, N Y—July, 1910. No. 15376 C.

WATERWAYS AND HARBORS.

Barge Canal.

The Erie Canal. Charles Prelini. First of a series of articles aiming to show the great historical, commercial, and political influence of the old Erie Canal, and to forecast the conditions that will arise from the improvements now in progress. 2500 w. Engng—July 1, 1910. Serial. 1st part. No. 15540 A.

Columbia River.

A 30-Year Record of Flow for the Columbia River. Abstracts of paper, No. 252, of the U. S. Geol. Survey, giving a summary of a notable record. 700 w. Eng News—June 30, 1910. No. 15400.

Constanza.

The New Harbor Works at Constanza, Roumania. Fr. Bock. Illustrated description of important improvements at this great grain port, on the Black Sea. 1500 w. Cassier's Mag—July, 1910. No. 15649 B.

Dry Docks.

Progress on Dry Dock No. 4, Brooklyn Navy Yard. An illustrated account of the difficulties met, the changes in original plans, and the progress of this work. 5000 w. Eng Rec—July 2, 1910. No. 15385.

The 22000-Ton Floating Dock for Brazil. Illustrated detailed description of the Rio de Janeiro dock built in Great Britain. 2000 w. Engr, Lond—July 8, 1910. Serial. 1st part. No. 15680 A.

The Dry Dock of the Société de la Gironde at Bordeaux (Le Bassin à Flot de la Société de la Gironde à Bordeaux). M. Michel-Schmidt. Describes its construction under difficult conditions. Ills. 18500 w. Mem Soc Ing Civ de France—April, 1910. No. 15706 G.

Italy.

Navigation from Lake Como to Milan (Per la Navigazione Lago di Como-Milans). N. Sacerdoti. Discusses the possibility of rendering the Adda navigable. Ills. 4000 w. Monit Tech—June 30, 1910. No. 15752 D.

Jamaica Bay.

Jamaica Bay Improvements. Illustration and brief account of a scheme of construction of channels, bulkheads, and the reclamation of land which, when completed, will provide the port of New York with 150 additional miles of water

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front. 1200 w. Sci Am—July 2, 1910. No. 15402.

Locks.

Locks and Weirs in the Weser at Bremen (Die Schleusen und Wehranlage in der Weser bei Bremen). Herr Oeltjen. Brief description. Ills. 1500 w. Deutsche Bau—June 18, 1910. No. 15907 B.

Loire.

The Works of "The Navigable Loire" (Les Travaux de "la Loire navigable"). Ch. Dantin. Describes the works carried out by the Navigable-Loire Association, a local society for the improvement of this French river. Ills. 5000 w. Génie Civil—June 25, 1910. No. 15739 D.

New York.

Report of Transportation Conditions at the Port of New York. Submitted by Calvin Tomkins, Commissioner of Docks. Especial reference to a joint railroad terminal in Manhattan on the North River above 25th Street. Plans. 7500 w. Dept of Locks & Ferries, New York—July, 1910. No. 15814 N.

Panama Canal.

The Construction of the Panama Canal (Vom Bau des Panama-Kanals). Hans Raschka. A discussion of the methods and progress of the work. Ills. 3000 w. Zeitschr d Oest Ing u Arch Ver—June 17, 1910. No. 15927 D.

Piers.

An Improvement in Pier Construction, San Francisco. Describes an improved method developed in constructing two piers in China Basin. Ills. 1200 w. Eng Rec—July 16, 1910. No. 15626.

New Concrete Piers at San Francisco. Illustrated description of the new steel and concrete piers and their construction. 1500 w. Marine Rev—July, 1910. No. 15602.

Pollution.

West Riding Rivers: 1904-1910. First of a series of articles dealing with the work of the West Riding Rivers Board, and the inaction of the Local Government Board, in regard to the purifying of polluted rivers. 4500 w. Engng—July 8, 1910. Serial. 1st part. No. 15676 A.

Port Said.

Port Said Harbor in 1909 (Der Hafen von Port-Said im Jahre 1909). Describes recent extensions and improvements to the harbor works. Ills. 2500 w. Oest Wochenschr f d Oeffent Baudienst—June 18, 1910. No. 15931 D.

Rock Removal.

The Submarine Rock Breaker in Trieste Harbor (Dérocheuse sous-marine du Port de Trieste). Brief description of the percussion breaker and the float on which it is carried. Ills. 1000 w. Génie Civil—June 4, 1910. No. 15733 D.

Shore Detritus.

The Accumulation of Shore Detritus During an Off-Shore Wind. A. H. Gibson. An explanation of the cause of this phenomenon. 2500 w. Engr, Lond—June 24, 1910. No. 15546 A.

Water Powers.

Utilization, Preservation and Conservation of Water Power. L. G. Carpenter. Slightly condensed address before the Colorado Conservation Commission. 1600 w. Eng Rec—July 23, 1910. No. 15879.

Wharves.

The Municipal Wharf at Montgomery, Ala.; A Novel Solution of the River Loading Problem. G. C. Scherer. Illustrated description of a double railroad track on concrete piers on which a movable wharf is lowered or hoisted. 500 w. Eng News—July 14, 1910. No. 15596.

Riverside Quay, Hull. Illustrated detailed description of a deep-water quay recently constructed in the Humber River for the improvement of port facilities. 1200 w. Engr, Lond—July 1, 1910. No. 15560 A.

MISCELLANY.

Contracts.

Standardizing Public Works Contracts. R. Walter Creuzbaur. Abstract of a paper, "The Necessity for Standardizing Contracts of the City of New York," read before the Nat. Assn. of Comptrollers and Acc. Officers. 2400 w. Eng News—July 28, 1910. No. 16026.

The Necessity for Standardizing Contract Forms. Condensed address, by R. Walter Creuzbaur, before the Nat. Assn. of Comptrollers and Accounting Officers. 2200 w. Eng Rec—July 2, 1910. No. 15391.

ELECTRICAL ENGINEERING.

COMMUNICATION.

Radiotelegraphy.

The Chambers Liquid Microphone. F. J. Chambers. Illustrated description of a novel form of transmitter, describing practical results. 1500 w. Elect'n, Lond—July 15, 1910. No. 15894 A.

A New System of Wireless Telegraphy. Illustrated description of the Bellini-Tosi apparatus. 1500 w. Sci Am Sup—July 16, 1910. No. 15600.

A Wireless Telegraph Station. Edward H. Guilford. Explains how to construct a 1000 miles receiving station. Ills. 2000 w. Sci Am Sup—July 23, 1910. Serial. 1st part. No. 15810.

Wireless Telegraphy (La Télégraphie sans Fil). S. Van Mierlo. A general re-

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view of theory, practice, apparatus, systems, etc., with statistics of established stations. Ills. 4500 w. Bul Sci d l'Assn d Elèves—April, 1910. No. 15700 D.

Telantograph.

The Walbrook Telewriter Exchange. Describes an exchange connected to about 50 subscribers in London. Ills. 1000 w. Elect'n, Lond—July 1, 1910. No. 15523 A.

Telegraphy.

American Telegraph Engineering—Notes on History and Practice. William Maver, Jr., and Donald McNicol. Gives a résumé of the early history of telegraph practice in America, and describes features of present practice. 12000 w. Pro Am Inst of Elec Engrs—July, 1910. No. 15282 F.

Developments in Telegraphy and Telephony. Sir John Gavey. Abstract of the "James Forrest" lecture before the Inst. of Civ. Engrs. A review of the rapid and important developments in the service. 4000 w. Elec Engr, Lond—July 1, 1910. Serial. 1st part. No. 15512 A.

Modern Submarine Telegraphy. Sidney G. Brown. Lecture at the Roy. Inst. Illustrates and describes the submarine cable and its electrical properties, mechanical difficulties, the instruments that work the cables, etc. 7000 w. Nature—July 7, 1910. No. 15655 A.

Telephony.

The History of the Telephone. Herbert N. Casson. First of a series of articles dealing with the telephone and telephone system. 3500 w. Elec Rev, N Y—July 9, 1910. Serial. 1st part. No. 15488.

DISTRIBUTION.

Switches.

Varied Applications of Tumbler Switches. Ewart B. Walker. Describes a few interesting applications. 500 w. Can Elec News—July, 1910. No. 15446.

DYNAMOS AND MOTORS.

A. C. Dynamos.

An Improvement in Single-Phase Alternators. Prof. C. Pichel-Mayer. Abstract translation from *Electrotechnische Zeit.* Describes means of avoiding dangerous pressures and of making the factor of safety equal to that of polyphase machines. 1200 w. Elect'n, Lond—June 24, 1910. No. 15520 A.

The Compounding of Alternators. A. Blondel. Slightly abbreviated from *Bul. de la Soc. Int. des Electns.* Describes the author's system and gives detail installations and test results. 2500 w. Elect'n, Lond—July 15, 1910. No. 15893 A.

A. C. Motors.

The Scherbius Motor and Some Methods of Working It in Cascade with Induction Motors. Reginald O. Kapp. Shows how this motor has been used to impart to the induction-motor the desired variable-speed characteristic. Ills. 5000 w. Elect'n, Lond—July 8, 1910. No. 15661 A.

Induction Motors.

Space Distribution of Magnetomotive Force. B. B. Brackett. A study of the magnetizing current in the three-phase induction motor. 1500 w. Elec Wld—July 28, 1910. No. 16022.

See also A. C. Motors, under DYNAMOS AND MOTORS.

Motor Reversing.

Reversing Motors. J. S. McKee. Gives curves showing the operation in motor reversing under stated conditions, and facts related. 1500 w. Sci Am Sup—July 16, 1910. No. 15599.

Starting Rheostats.

Method of Calculating Starting Rheostats for Continuous-Current Motors (Metodo per Calcolare i Reostati d'Avviamento dei Motori a Corrente continua). Carlo Righini. Mathematical demonstration. Ills. 2000 w. Industria—June 5, 1910. No. 15755 D.

Synchronizing.

The Sensitiveness of Synchronizing Apparatus. J. Teichmüller. Abstract translation from *Elektrotechnische Zeit.* Illustrates systems of connection and examines their sensitiveness. 1200 w. Elect'n, Lond—June 24, 1910. No. 15522 A.

Voltage Regulation.

The New Wolff Regulating System for Hydroelectric Plants (Das neue Wolffsche Reguliersystem für hydroelektrische Kraftanlagen). F. Simmerding. Detailed description of the apparatus. Ills. 1500 w. Elektrotech u Maschinenbau—June 12, 1910. No. 15944 D.

ELECTRO-CHEMISTRY.

Corrosion.

The Corrosion of Iron and Steel. Report of Committee A5 of the American Society for Testing Materials. 4000 w. Eng Rec—July 9, 1910. No. 15451.

The Formation of Rust (La Formation de la Rouille). G. Bresch. A review of theories of iron corrosion. Ills. 4500 w. Rev de Métal—June, 1910. No. 15711 E + F.

Electric Furnaces.

Current and Voltage Conditions in the Electric Furnace (Ueber Strom- und Spannungsverhältnisse im elektrischen Ofen). Walter Conrad. Read at the Düsseldorf Congress. A discussion of the application of energy in electric furnaces. Ills. 2200 w. Stahl u Eisen—June 22, 1910. No. 15779 D.

Electrodes.

A Graphite Cathode Dish. J. W. Turrentine. Abstract of paper before the Am. Elec.-Chem. Soc. Describes simple graphite electrodes designed for use in place of platinum as insoluble electrodes in electrochemical experiments. Reports experiments with a graphite dish intended to supplant the Classen platinum dish. 1500 w. Elect'n, Lond—June 24, 1910. No. 15521 A.

We supply copies of these articles. See page 966.

ELECTRO-PHYSICS.

Air Strength.

The Electric Strength of Air. J. B. Whitehead. Describes an investigation to develop an accurate method of determining the electric strength of air in the neighborhood of round wires, and its application. 8000 w. Pro Am Inst of Elec Engrs—July, 1910. No. 15273 F.

Alternating Currents.

Vector Power in Alternating-Current Circuits. A. E. Kennelly. Aims to indicate the limitations under which power in an alternating-current circuit may be treated as a stationary vector, to extend the technology of vector a. c. quantities, to combat the use of the terms "wattless power" and "wattless current," and to offer a plea for standardization. Diagrams. 7000 w. Pro Am Inst of Elec Engrs—July, 1910. No. 15272 F.

Commutation.

Commutation (La Commutation). Marius Latour. A continuation and conclusion of the author's previous communication. Ills. 6000 w. Bul Soc Int des Elecns —June, 1910. No. 15708 F.

High-Frequency Discharges.

Experiments on the Destructive Effects of High-Frequency Oscillating Discharges (Quelques Experiences sur les Effets distructifs des Décharges oscilliantes de grand Fréquence). M. Courtois. Describes the experiments and illustrates the results. 2000 w. Bul Soc Int des Elecns —June, 1910. No. 15707 F.

Induction.

The Simplification of Electrical Theories (Beiträge zur Vereinheitlichung elektrischer Theorien). Hermann Zipp. An attempt to simplify the theory of all kinds of apparatus in which energy transformation occurs by means of magnetic fluxes. Ills. Serial. 1st part. 4000 w. Elektrotech u Maschinenbau—June 19, 1910. No. 15945 D.

Physiological Effects.

The Physiological Tolerance of Alternating-Current Strengths Up to Frequencies of 100,000 Cycles per Second. A. E. Kennelly and E. F. W. Alexanderson. Reports a series of tests relating to the physiological tolerance of a. c. of high frequencies. 1800 w. Elec Wld—July 21, 1910. No. 15828.

Spark Gaps.

Short Spark Gaps. D. Owen. Gives results of research work. 2200 w. Elect'n, Lond—July 1, 1910. No. 15525 A.

GENERATING STATIONS.

Accumulators.

The Use of Storage Batteries in Direct-Current and Alternating Current Central Stations. R. Werkner. Abstract translation from *Elektrotechnick und Maschinenbau*. Discusses the relation of storage batteries to the different systems of generation and distribution. 2000 w. Elec Rev, N Y—July 23, 1910. No. 15869.

See also Boosters, under GENERATING STATIONS.

Boosters.

The Entz Reversible Booster and the Chloride Accumulator at the Blackburn Electricity Works. Illustrates and describes the successful operation of an Entz booster-battery combination. 1800 w. Elec Rev, Lond—July 8, 1910. No. 15659 A.

Central Stations.

Electricity Supply in Dundee, Scotland. Robert L. Reid. An illustrated account of the new high-tension system. 4000 w. Elec Rev, N Y—July 2, 1910. Serial. 1st part. No. 15331.

See also Refuse Disposal, under CIVIL ENGINEERING, MUNICIPAL.

Construction.

Reinforced-Concrete Construction for Electric Light and Power Plants (Installation elektrischer Licht- und Kraftanlagen in Eisenbetonbauten). Siegfried Ebell. Discusses the applicability of this material to various parts of the construction. Ills. 2500 w. Beton u Eisen—June 10, 1910. No. 15934 F.

Costs.

See also Blast-Furnace Gas, under MINING AND METALLURGY, IRON AND STEEL.

Economics.

Commercial Progress of Electricity Undertakings. H. Collings Bishop. Read before the Munic. Elec. Engrs. Assn., Glasgow. Discusses the development of the commercial side, methods, etc. 4000 w. Elec Engr, Lond—July 15, 1910. No. 15888 A.

See also Central Plants, under MECHANICAL ENGINEERING, HEATING AND COOLING.

Hydroelectric.

A General Review of Hydroelectric Engineering Practice. Frank Koester. This fifth article of a series discusses high-tension transmission lines and apparatus. Ills. 4500 w. Engineering Magazine—August, 1910. No. 15099 B.

The Construction of the Great Western Power Plant. Illustrated description of construction work in California, explaining conditions. 2500 w. Eng Rec—July 16, 1910. No. 15631.

Power Developments of the Lehigh Valley Transit Company. Explains the consolidation of four railway systems under this name, and the general power arrangements, illustrating and describing the Allentown power plant, and generating equipment. 2500 w. Elec Ry Jour—July 30, 1910. No. 16034.

The Trient Electrical Works (Die Elektrizitätswerke der Stadt Trient). Ernst Rudolph. Illustrated detailed description of the water-power development of this Austrian city. Serial. 1st part.

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3000 w. Elektrotech u Maschinenbau—June 26, 1910. No. 15946 D.

The Tuilière Hydro-Electric Plant on the Dordogne, and Energy Distribution in the Region of the Southwest (L'Usine hydro-électrique de Tuilière sur la Dordogne et la Distribution de l'Energie électrique dans la Région du Sud-Ouest). Albert Claveille. An exhaustive detailed description. Ills. 33000 w. Ann d Ponts et Chaussées—1910—III. No. 15742 E + F.

The Straschin-Prangschin Dam and Power Plant (Die Talsperre und das Ueberland-Kraftwerk bei Straschin-Prangschin). A. Behrendt and H. Bökenkamp. Describes an extensive power development near Danzig, Germany. Ills. 10500 w. Zeitschr d Ver Deutscher Ing—June 25, 1910. No. 15957 D.

See also Irrigation, under CIVIL ENGINEERING, WATER SUPPLY.

Isolated Plants.

Isolated Industrial Generating Installation. Albert L. Clough. Plan and description of the steam turbo-generator and induction-motor equipment of Amoskeag textile mills. 2500 w. Elec Wld—July 28, 1910. No. 16020.

Rates.

Rate Making for Public Utilities. Percy H. Thomas. Discusses the decision of the R. R. Commission of Wis. in the case of the State Jour. Printing Co. vs. the Madison Gas & Elec. Co., rendered March 8, 1910. 5000 w. Elec Jour—July, 1910. No. 15853.

Sale of Electrical Energy by the Central Colorado Power Company. Discusses the rates and methods of charging for retail service. 1200 w. Elec Wld—July 28, 1910. No. 16023.

Switchboards.

Alternating-Current Industrial Power-Plant Switchboards. Warren H. Miller. Aims to show what can be done with simple a. c. boards for various classes of service. Ills. 2500 w. Elec Rev, N Y—July 23, 1910. Serial. 1st part. No. 15870.

LIGHTING.

Arc Lamps.

Flaming Arc Lamps. Newton Harrison. Explains the means of producing light in arc lamps, how flaming arc lamps burn in circuit, and the conditions of use. 2500 w. Cent Sta—July, 1910. No. 15422.

Incandescent Lamps.

The Tungsten Lamp Situation in France. Warren H. Miller. A report of the rapid introduction of tungsten lamps in Paris. 1500 w. Elec Wld—July 7, 1910. No. 15483.

Tests of Tungsten Lamps (Untersuchungen an Wolfram-Lampen). Alois Berninger and Robert Schuster. Detailed results of tests at the Imperial Technological Institute, Vienna. Ills. Serial. 1st part. 3000 w. Elektrotechniker—June 10, 1910. No. 15938 D.

An Advance in the Construction of Glow-Lamp Fittings (Ein Fortschritt im Bau von Glühlampenarmaturen). M. Gerstmeyer. Describes recent improvements in lamp sockets. Ills. Serial. 1st part. 1500 w. Elektrotech Rundschau—June 23, 1910. No. 15942 D.

Mercury-Vapor Lamps.

Practical Notes on Illumination by Cooper-Hewitt Mercury Lamps. L. Crouch. Remarks on the Heraeus quartz mercury vapor lamp, and the points in which it is superior and inferior to the Cooper-Hewitt, giving costs of installing and operating mercury vapor lamp equipments, etc. 1400 w. Elec Rev, Lond—July 15, 1910. Serial. 1st part. No. 15891 A.

Photometry.

Carbon Filament Lamps as Photometric Standards. E. B. Rosa and G. W. Middlekauff. Describe a recent study made of the performance of carbon filament electric lamps as photometric standards. An account of work of the Bureau of Standards. Ills. 4500 w. Pro Am Inst of Elec Engrs—July, 1910. No. 15279 F.

A New Form of Direct-Reading Candle-Power Scale and Recording Device for Precision Photometers. George W. Middlekauff. Describes the new apparatus in use in the United States Bureau of Standards. 3000 w. Elec Wld—July 21, 1910. No. 15827.

The Measurement of Surface-Brightness. J. S. Dow. Illustrates and describes the Dow-Mackinney photometric instrument and its use. 2500 w. Elec Rev, N Y—July 16, 1910. No. 15640.

Street.

Public Lighting from a Municipal Point of View. Jacques Abady. Abstract of a paper read before the Inst. of Gas Engrs. Discusses the relative merits of street lighting contracts in vogue, favoring the buying by light value. Considers the location of lamps, distribution of light and related subjects. 6500 w. Elect'n, Lond—July 8, 1910. No. 15660 A.

MEASUREMENT.

Alternating Current.

Some Recent Developments in Exact Alternating-Current Measurements. Clayton H. Sharp and William W. Crawford. Describes certain new methods and apparatus. Ills. 6500 w. Pro Am Inst of Elec Engrs—July, 1910. No. 15280 F.

Galvanometers.

Galvanometer for A. C. Circuits. Dr. W. E. Sumpner and W. C. S. Phillips. Abstract of paper and discussion before the Phys. Soc. of London. Describes a galvanometer by means of which inductances and capacities can be compared by bridge methods as accurately as it is possible to compare resistances. 1500 w. Elec Engr, Lond—July 15, 1910. No. 15889 A.

We supply copies of these articles. See page 966.

Hysteresis.

Magnetic Hysteresis. Morton G. Lloyd. Treats of the latest methods of measuring magnetic quality in general and in particular the losses which occur in iron and iron alloys when placed in alternating and rotary magnetic fields. 5500 w. Jour Fr Inst—July, 1910. No. 15846 D.

Insulator Testing.

Mechanical Tests of Insulator Porcelain and Glass. Ralph P. Clarkson. An illustrated report of experimental tests. 1500 w. Elec Wld—July 7, 1910. No. 15482.

Laboratories.

The Arrangement of Experimental Electrical Circuits for Laboratories. W. P. Steinthal. Abstract of paper before the Inst. of Elec. Engrs. Discusses the requirements and describes the arrangement of circuits, and switch and plug boards. Ills. 4500 w. Elect'n, Lond—June 24, 1910. No. 15516 A.

Meters.

Investigating Manufacturing Operations with Graphic Meters. C. W. Drake. On the use of these meters to give continuous records, illustrating by examples. Ills. 2000 w. Elec Jour—July, 1910. No. 15852.

Some Notes on Meters of the Thomson-Houston Type. Paul May. Abstract translation from *Elektrotechnische Zeit.* Notes showing methods of reducing the depreciation of these meters. 1700 w. Elect'n, Lond—July 1, 1910. No. 15524 A.

Motor Testing.

See Dynamometers, under MECHANICAL ENGINEERING, MEASUREMENT.

Permeameters.

A Comparison of Magnetic Permeameters. Charles W. Burrows. Reports an investigation made to determine what agreement exists between magnetic data of different experimenters working with different apparatus. 2000 w. Elec Rev, N Y—July 16, 1910. No. 15638.

Transformer Testing.

Indirect Testing of Instrument Transformers by High-Tension Current (Prova indiretta dei Trasformatori di Misura per forti Intensita di Corrente). Angelo Barbagelata. Mathematical discussion of the method. Ills. 2000 w. Monit Tech—June 10, 1910. No. 15750 D.

See also Shop Practice, under MECHANICAL ENGINEERING, MACHINE WORKS AND FOUNDRIES.

Tuning Forks.

The Electric Tuning Fork (Contribution à la Technique de l'Electro-Diapason). A. Guillet. A technical discussion of tuning-fork circuit breakers and their uses. Ills. 6000 w. Tech Mod—June, 1910. No. 15722 D.

Units.

The International Electrical Units 1893-1910. E. B. Rosa. A review of the work that has been done toward establishing international electrical units. 4000 w. Pro Am Inst of Elec Engrs—July, 1910. No. 15284 F.

Wheatstone Bridge.

The Design of a Quick-Acting Wheatstone Bridge. Charles R. Underhill. Illustrated description of an instrument which has given great satisfaction for accurate use. 700 w. Elec Wld—July 7. 1910. No. 15484.

POWER APPLICATIONS.

Heating.

Electric Heating and Pyrometry. Abstract of the Tyndall lecture delivered by Prof. J. A. Fleming at the Royal Institution. Discusses methods of electric heating. Ills. 3500 w. Engng—June 10, 1910. No. 15500 A.

TRANSMISSION.

Conduits.

Improvements Suggested in Underground Conduit Construction for Large Transmission Systems. Edw. N. Lake. Suggests improvements with reference to the new ideas of isolation and protection of the cables for which the conduits are built. Ills. 12800 w. Jour W Soc of Engrs—June, 1910. No. 15857 D.

Gas Explosions in an Electric Conduit, New York City. A. A. Breneman. Description and discussion of the cause, showing that a good and continuous system of ventilation is essential. 3500 w. Eng News—July 14, 1910. No. 15592.

Fault Location.

Localization of Faults on Underground Mains. W. A. Toppin. Abstract of paper read before the Glasgow Sec. of the Inst. of Elec. Engrs. Describes a simple method of locating earth leakages and the apparatus used. 2500 w. Elect'n, Lond—July 15, 1910. No. 15892 A.

Insulators.

An Experimental Research on Glass and Porcelain Insulators (Ricerche sperimentali sugli Isolatori di Vetro e di Porcellana). Gino Rebora. Reports results of tests. 2500 w. Monit Tech—June 30, 1910. No. 15753 D.

Line Construction.

Construction of 135,000-Volt Transmission into Flint and Battle Creek, Mich. Brief descriptive account of a development on the Au Sable River. 1000 w. Elec Wld—July 14, 1910. No. 15587.

High-Tension Railway Crossings (Kreuzungen von Eisenbahnen durch Hochspannungsleitungen). R. Ulbricht. Discusses mast construction and wire suspension. Ills. 2000 w. Elek Kraft u Bahnen—June 4, 1910. No. 15936 D.

Line Design.

Low Tension Feeder Systems for Street Railways. R. H. Rice. Explains the methods used in calculating the feeders, showing the general results obtained on the street railway systems of Chicago. 4500 w. Jour W Soc of Engrs—June, 1910. No. 15856 D.

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Poles.

Poles and Pole Lines. F. L. Rhodes. Read before the N. Eng. Tel. Soc. Considers the most economical pole for use in each section, rates of increase in strength, preservatives, line wire, etc. 4000 w. Can Engr—July 21, 1910. No. 15865.

See also Timber Preservation, under CIVIL ENGINEERING, MATERIALS OF CONSTRUCTION.

Substations.

Distribution of Energy in Colorado. Illustrates and describes the substations of the Central Colorado Power Company. 1800 w. Elec Wld—June 30, 1910. No. 15356.

Toronto.

Toronto's Electrical Distribution System. H. C. Barber. Illustrated description of a system using underground distribution in congested sections. 1000 w. Can Elec News—July, 1910. No. 15449.

Transformers.

Determination of Transformer Regulation Under Load Conditions and Some Resulting Investigations. Adolph Shane. Explains a direct method, as well as an accurate calculated method, of checking the results with particular transformers, points out errors in the ordinary method, giving the causes. 4000 w. Pro Am Inst of Elec Engrs—July, 1910. No. 15274 F.

Transformers in Three-Phase Circuits. I. Current and Voltage Relations in Open-Delta Connections. R. G. Lafite. II. Current Relations in, and Power-Factor of, an Unbalanced Three-Phase Circuit. R. K. McMaster. Clears up difficult points, and gives simple methods of determining the currents and power-factor. 2000 w. Elec Wld—June 30, 1910. No. 15359.

Voltage Regulation.

Notes on Transmission Line Regulation. P. M. Lincoln. Describes a method of approximating transmission line regulation which has been of use and is sufficiently accurate. 3000 w. Can Engr—July 14, 1910. No. 15637.

MISCELLANY.

Fire Alarms.

Automatic Fire Alarms. Remarks on the conflict of interests between the insurance companies and the public, especially relating to conditions in London. 2500 w. Elec Rev, Lond—July 1, 1910. No. 15515 A.

Inspection.

Report of H. M. Electrical Inspector of Factories. Information from the annual report of G. Scott Ram. Also editorial. Ills. 6500 w. Mech Engr—June 24, 1910. No. 15529 A.

Insulating Materials.

Gutta-Percha and Substitutes. Information concerning the production, manufacture and commercial uses of gutta-percha, balata, jelotong, and other substitutes. 2000 w. Sci Am Sup—July 2, 1910. No. 15404.

Insulating Oils.

Dielectric Strength of Oil. H. W. Tobey. Outlines some of the more important characteristics of oil, with special reference to dielectric strength, giving results of extensive tests. Ills. 5500 w. Pro Am Inst of Elec Engrs—July, 1910. No. 15278 F.

INDUSTRIAL ECONOMY.

Depreciation.

Depreciation. George Johnson. Discusses methods of providing for shrinkage in value. 2500 w. Elec Rev, Lond—June 24, 1910. No. 15513 A.

The Ethics of Allowances for Depreciation. L. S. Randolph. Discusses three possible general policies and their physical and financial effects. 1800 w. Engineering Magazine—Aug., 1910. No. 16001 B.

Depreciation and Maintenance Costs in Factory Operation (Abschreibungen und Instandhaltungskosten in Fabrikbetrieben). Jul. H. West. Discusses methods of making depreciation allowances, accounting, etc. 4500 w. Tech u Wirt—June, 1910. No. 15960 D.

Designing.

Cost in Engineering Design. Editorial on the necessity of draughtsmen studying carefully the cost without impairing the efficiency. 1800 w. Engng—July 8, 1910. No. 15675 A.

Education.

Applying an Industrial System for Efficiency in Technical Instruction. S. E. Slocum. Read before the Soc. for the Pro. of Engng Ed. Shows how the Taylor system of shop management may be used effectively in this field. 2000 w. Eng News—July 7, 1910. No. 15411.

Co-operative Engineering Education. Herman Schneider. From a paper read before the Soc. for the Pro. of Engng. Ed. Explains the system of the University of Cincinnati. 3000 w. Ry Age Gaz—July 15, 1910. No. 15613.

Broader View of Industrial Education. Dexter S. Kimball. An expression of the writer's views in regard to the system that promises the best results. 3000 w. Am Mach—Vol. 33. No. 29. No. 15695.

Economic Seminary of the Berlin Technical High School (Das volkwirtschaftliche Seminar der kgl. Technischen Hochschule zu Berlin). C. Walther. Discusses

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the organization for instruction in economics and sociology. 2200 w. Tech u Wirt—June, 1910. No. 15959 D.

The Danzig Technical High School (Die Technische Hochschule zu Danzig). R. Rössler. A review of its development, courses, methods, equipment, etc. Ills. 12000 w. Zeitschr d Ver Deutscher Ing—June 25, 1910. No. 15955 D.

Engineering.

The Qualities for Success in Engineering. Dr. Ira N. Hollis. Address before the Class of 1910, Worcester Polytechnic Institute. 6500 w. Jour Worcester Poly Inst—July, 1910. No. 15819 C.

The Engineer's Duty as a Citizen. George W. Melville. Address at the Atlantic City meeting of the A. S. M. E. Calls attention to the improvements due to the engineering profession, their important part in the present life, and their duty to take an active part in everything affecting the common good. 2500 w. Jour Am Soc of Mech Engrs—July, 1910. No. 15833 F.

Engineering Commissions.

Special Engineering Commissions. Editorial discussion of commission work and the principles governing it. 2500 w. Eng News—July 21, 1910. No. 15807.

Exhibitions.

The Brussels Universal Exposition, 1908 (L'Exposition universelle de Bruxelles, 23 Avril-October, 1910). L. Ramakers. A general description of the grounds, buildings, and exhibits. Ills. 3000 w. Génie Civil—June 11, 1910. No. 15735 D.

Filing Systems.

Indexing System for Boiler and Plate Metal Shops Covering Blue Prints, Tracings, and Batteries. Edwin E. Rohrer. Describes a convenient method, showing the advantage of system. 1200 w. Boiler Maker—July, 1910. Serial. 1st part. No. 15582.

Germany.

East-German Industry (Die ostdeutsche Industrie). W. John. Discusses the industrial development of the eastern provinces of Germany. 9000 w. Zeitschr d Ver Deutscher Ing—June 25, 1910. No. 15954 D.

Labor Insurance.

Sickness and Death Rates in the Leipzic and District Sick Fund (Die Krankheits- und Sterblichkeits-Verhältnisse der Krankenkasse für Leipzig und Umgegend). Dr. Bender. Reports causes of illness, distribution among various industries, effects of alcohol, etc. 3500 w. Tech u Wirt—June, 1910. No. 15962 D.

Management.

The Twelve Principles of Efficiency. Harrington Emerson. This third article of a series discusses the first principle—Clearly Defined Ideals. 5500 w. Engineering Magazine—August, 1910. No. 16000 B.

How the Foremen Can Promote Shop Efficiency. C. L. Alden. One of the articles submitted in the competition which closed April 15. Deals mostly with the proper treatment of employees. 1200 w. Ry Age Gaz—July 1, 1910. No. 15362.

Overhead Charges and Shop Output. Holden A. Evans. Notes on good shop management with particular reference to its relation to overhead expenses. 3000 w. Am Mach—Vol. 33. No. 30. No. 16011.

Costs of Machine-Tool Operations in Steam-Engine. Manufacturing. William O. Webber. Gives facts showing reductions due to efficiency methods. 2000 w. Engineering Magazine—August, 1910. No. 16004 B.

Paraguay.

Paraguay (Mededeelingen over Paraguay). M. J. de Bosch Kemper. Discusses political and industrial conditions. 6500 w. De Ingenieur—June 18, 1910. No. 15965 D.

Patents.

The Status of Alloys under the Patent Law (Ueber die patentrechtliche Stellung der Legierungen). Victor Samter. Discusses the situation in Germany. Serial. 1st part. 1500 w. Giesserei-Zeit—June 1, 1910. No. 15780 D.

Profit Sharing.

New System of Profit Sharing (Nouvelle Forme de la Participation des Travailleurs aux Bénéfices industriels). Sylvain Périssé. Suggests a system for general use in France and gives results of its operation in six establishments. 5000 w. Génie Civil—June 4, 1910. No. 15732 D.

Strikes.

The Right to Strike: Its Limitations. Joseph J. Feely. From an article in the *N. Am. Rev.* An interesting discussion of strikes that involve the public welfare. 2500 w. Ry Age Gaz—July 29, 1910. No. 16042.

Trade Secrets.

Trade Secrets in the Electrochemical Industry (Technische und Herstellungsgeheimnisse in der elektrochemischen Industrie). Discusses their nature and importance and the new German law for their protection. Serial. 1st part. 1500 w. Elektrochem Zeitschr—June, 1910. No. 15761 D.

Trusts.

A Comparison of the American Iron and Coal Trusts with the German Kartel System (Comparaison du Système des Trusts americains dans l'Industrie du Fer et de la Houille avec Système allemand des Syndicats ou Kartelle). M. Pilz. Abstracted from *Glückauf*. 11500 w. Rev de Métal—June, 1910. No. 15713 E + F.

Wage Systems.

Wage Systems in American Railway Shops with Special Reference to the Santa Fe Bonus System (Das Lohnwesen in amerikanischen Eisenbahnwerkstätten, un-

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ter besonderer Berücksichtigung des Bonus-Lohnsystems der Santa Fe-Bahn). Bruno Schwarze. The first part discusses the systems of the B. & O. and the Pennsylvania. Forms. Ills. Serial. 1st part. 4000 w. Glasers Ann—June 1, 1910. No. 15921 D.

See also same title, under CIVIL ENGINEERING, CONSTRUCTION.

Workmen's Houses.

The Ninth International Small-Habitations Congress, Vienna, 1910 (Le IX^e Congrès international des Habitations à bon Marché, Vienne, May-June, 1910). Maurice Bellom. A report of the proceedings of the Congress, dealing with the housing of workmen. 3000 w. Génie Civil—June 18, 1910. No. 15738 D.

MARINE AND NAVAL ENGINEERING.

Battleships.

The First Dreadnought. Letter from William Boerum Wetmore, giving information and illustration of the ironclad "Onondaga," authorized by the U. S. Congress in 1861. 800 w. Sci Am—July 23, 1910. No. 15808.

German Battleships. Photographs and information concerning four battleships of the Dreadnought type now completed for the German Navy. 1000 w. Engng—June 10, 1910. No. 15499 A.

British Navy.

Progress of Warships and Machinery Under Construction in England. Half-yearly report of progress in Great Britain. 2500 w. Engr, Lond—July 1, 1910. No. 15564 A.

Cruisers.

Ninety-four-Foot Cruiser. Plans and description. 1200 w. Rudder—July, 1910. No. 15352 C.

Davits.

Quadrant Davit for Double-Banked Boats. Illustrated description of a new design of the Welin quadrant davit. 1000 w. Engng—July 1, 1910. No. 15543 A.

Destroyers.

The Latest Turbine Destroyers of the French Navy. Illustrated article giving the main particulars of these vessels, and describing details. Also reporting the results of the different modes of propulsion. 3000 w. Int Marine Engng—July, 1910. No. 15367 C.

Torpedo-Boat Destroyer *Voltigeur* (Torpedojäger "Voltigeur"). Describes and gives performance of the recent additions to the French Navy. 4000 w. Schiffbau—June 8, 1910. No. 15901 D.

Electric Power.

Electricity on Shipboard. J. M. Heslop. Abstract of a lecture delivered before the Engineering Society of the Technical College of Sunderland dealing with special applications. 4000 w. Cassier's Mag—July, 1910. No. 15650 B.

Regulation in Electrical Propulsion (Reguliermethoden für den elektrischen Propellerantrieb). Alex. Simon. Describes methods of regulating propeller speed. Ills. 2000 w. Schiffbau—June 22, 1910. No. 15904 D.

Floating Cranes.

The Development of Floating Cranes (Die Entwicklung der Schwimmkrane). Herr Wintermeyer. Describes various types. Ills. 4500 w. Schiffbau—June 8, 1910. No. 15900 D.

Hydroplanes.

The Skimming Boat. Illustrated detailed description of the Miranda IV, a motor boat built by John I. Thornycroft & Co., Ltd. 1000 w. Engr, Lond—July 15, 1910. No. 15977 A.

Internal-Combustion Engines.

Internal-Combustion Engines for Marine Use. W. R. Cummins. Read before the Inst. of Marine Engrs., at the Japan-British Exhibition. An outline of the writer's ideas concerning internal-combustion plants for marine work. 4800 w. Mech Engr—July 1, 1910. No. 15531 A.

Marine Gas Engines. Gives rules for the survey of internal-combustion engines for marine purposes, drawn up by Lloyd's Register. 1000 w. Engr, Lond—June 24, 1910. No. 15554 A.

Model Cutting.

Machine for Cutting Wax Ship-Models at the National Physical Laboratory. Illustrated description of the apparatus installed for the manufacture of the wax models used for tests. 1800 w. Engng—July 8, 1910. No. 15677 A.

Oil Engines.

180-Brake-Horse-Power Reversible Marine Oil-Engine. Illustrated description of an engine of the 4-cylinder type, each cylinder being 12 ins. in diameter. 700 w. Engng—July 8, 1910. No. 15673 A.

Propellers.

Speed Propeller Wheels. Harry J. Perkins. An explanatory article on the design, construction and selection of proper wheels. 3000 w. Rudder—July, 1910. No. 15351 C.

Ship Propulsion by Radial Reaction Propellers (Antrieb von Schiffen mittels radialen Reaktionspropellers). Felix Langen. Mathematical. 3500 w. Zeitschr f d Gesamte Turbinenwesen—June 10, 1910. No. 15912 D.

Propulsion.

The Propulsion of Cargo-Boats. R. M. Neilson. A comparative study of the

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best modern system of propulsion in view of recent engineering developments. Ills. 11000 w. Cassier's Mag—July, 1910. No. 15648 B.

Shipbuilding.

Shipbuilding Estimates. J. A. Pearson. Read before the Greenock Assn. of Engrs. & Ship Bldrs. Discusses the making of estimates, considering material, wages, purchases, and establishment charges. 2500 w. Mech Wld—July 15, 1910. Serial. 1st part. No. 15897 A.

Reduction in Cost of Navy Yard Work. Holden A. Evans. Explains how scientific management resulted in reductions in cost. 4000 w. Am Mach—Vol. 33. No. 26. No. 15338.

The Schichau Works in Elbing, Danzig and Pillau (Die Schichau-Werke in Elbing, Danzig and Pillau). Describes the development of these German shipyards. Ills. 6000 w. Zeitschr d Ver Deutscher Ing—June 25, 1910. No. 15956 D.

Ship Stability.

Calculation of the Transverse Stability of Ships (Beitrag zur Berechnung der Querstabilität von Schiffen). Jul. Ott. Detailed demonstration of the method. Ills. Serial. 1st part. 5000 w. Schiffbau—June 22, 1910. No. 15903 D.

Spanish Navy.

The New Spanish Navy. Briefly reviews the scheme for building a modern fleet and reconstructing the naval arsenals, and gives illustrated descriptions of three new battleships. 3000 w. Engng—July 15, 1910. No. 15971 A.

Steamboats.

San Francisco Bay Steamer Napa Valley. A vessel for passenger and excursion traffic is illustrated and described. 1200 w. Marine Rev—July, 1910. No. 15603.

Steam Engines.

Economical Operation of Marine Engines (Sull' Economia di Esercizio delle Macchine a Vapore Marine). Benvenuto Rossi. Deals principally with problems of lubrication. Ills. 5000 w. Riv Marit—June, 1910. No. 15745 E + F.

Steamships.

Passenger and Freight Steamships City of Montgomery and City of St. Louis. Illustrates and describes the two latest vessels for the New York-Savannah service. 3500 w. Int Marine Engng—July, 1910. No. 15368 C.

The White Star Line. A review of the development of this important steamship line, illustrating notable vessels, and describing their construction and equipment. Plates. 12000 w. Engr, Lond (Sup)—June 24, 1910. No. 15555 A.

The "Jan Breydel" and "Pieter de Coninck" on the Ostend-Dover Service. Illustrated detailed description of new turbine vessels for cross-channel service. Plate. 3500 w. Engng—July 15, 1910. No. 15973 A.

Four New Twin-Screw Steamers for the Nippon Yusen Kaisha European Line. An illustrated article giving particulars of the Kamo-Maru, Hirano-Maru, Atsuta-Maru, and Kitano-Maru, built in Japan. 3500 w. Int Marine Engng—July, 1910. No. 15366 C.

Submarines.

A New Type of Submarine Boat. Brief illustrated description of Bayer's duplex boat. 600 w. Sci Am Sup—July 9, 1910. No. 15416.

Ballast and Diving Arrangements in Submarine Design (Ballast- und Tauchеinrichtungen für ein Unterseeboot-Rohprojekt). Karl Dietze. A discussion of the design of submarines. Ills. 2000 w. Schiffbau—June 22, 1910. No. 15902 D.

Survey Vessels.

Survey Steamship for Canada. Illustrated description of the "Cartier," a new twin-screw survey steamer for the Canadian Government. 700 w. Engr, Lond—June 24, 1910. No. 15549 A.

MECHANICAL ENGINEERING.

AUTOMOBILES.

Ball Bearings.

Loads on Ball Bearings in Gear Transmissions. J. Dornacher. Trans. from *Der Motorwagen.* An examination of ball bearing loads at the different gear speeds in a number of automobiles, with disregard of friction losses. 2000 w. Automobile—July 28, 1910. No. 16039.

Loads on Automobile Ball Bearings (Belastung von Kugellagern in Automobilgetrieben). J. Dornacher. Gives tables showing loads at various speeds in cars of many makers. Ills. Serial. 1st part. 2500 w. Motorwagen—June 10, 1910. No. 15917 D.

Clutches.

See same title, under MACHINE ELEMENTS AND DESIGN.

Commercial Vehicles.

Gasoline-Electric Truck for Haulage in Arid Regions. W. D. Hornaday. Describes an interesting transportation line between Marathon, Tex., and a point on the Rio Grande 80 miles south, explaining the conditions and illustrating the vehicle. 1000 w. Elec Wld—July 21, 1910. No. 15829.

Construction.

Economy in Materials in Automobile Construction (Wirtschaftliche Materialdifferenzierung im Automobilbau). N.

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Stern. Discusses the use of special steels, etc., Serial. 1st part. 1500 w. Motorwagen—June 30, 1910. No. 15918 D.

Control.

A New "Gate-Change" with Ever-Meshing Gears. Illustrated description of the latest Adams development in pedal operation of gears. 1500 w. Auto Jour—June 25, 1910. No. 15509 A.

Electric.

Progress in Electric Vehicles (Neuerungen im elektrischen Kraftwagenbetrieb). W. Wolf. The first part describes recent types of motors. Ills. Serial. 1st part. 1200 w. Motorwagen—June 30, 1910. No. 15919 D.

Fire Apparatus.

Modern Automobile Fire Apparatus (Moderne Feuerwehrautomobile). Describes various types and makes of fire apparatus. Ills. Serial. 1st part. 4000 w. Zeitschr d Mit Motorwagen Ver—June 30, 1910. No. 15916 D.

Fuels.

Conservation Idea in Its Application to Motoring. Albert L. Clough. Discusses the subject as applied to liquid fuels, their waste, production, etc. 2200 w. Horseless Age—June 29, 1910. No. 15311.

Fuel and Oil for Motor Cars. J. Veitch Wilson. Excerpts from a paper read before the Coventry Engng. Soc. Deals with the petroleum industry, oil refinement, economical methods, etc. 3000 w. Auto Jour—July 2, 1910. Serial. 1st part. No. 15510 A.

Some Points Worth Knowing About Automobile Gasoline. Shows that automobile gasoline is but slightly related to technical gasoline, and discusses temperature, efficiency of combustion, and the excess of air needed. 1600 w. Automobile—July 21, 1910. No. 15822.

Alcohol and the External Combustion Engine. William D. Ennis. Discusses alcohol as a fuel and the binary vapor principle. Compares the characteristics of various fuels. 2500 w. Automobile—July 28, 1910. No. 16037.

Fuel Tanks.

Studies Involving Refinements of Gasoline Equipment. Points out that the filler car for the gasoline tank should be made so that it will hold pressure; and that gasoline will not flow through a fine wire mesh if it is first wetted by water. Ills. 2200 w. Automobile—June 30, 1910. No. 15313.

Hotchkiss.

The 12-16 H. P. Hotchkiss. Illustrates and describes a departure from usual practice in the clutch design. 1000 w. Autocar—July 9, 1910. No. 15658 A.

Ignition.

High Potential Test on Porcelain Spark Plugs. Tests were made to ascertain the dielectric strength of the porcelain used under the conditions fixed in spark plug. 1200 w. Automobile—June 30, 1910. No. 15314.

Action of the Inductor Magneto. F. P. McDermott, Jr. Reviews fundamental principles of electricity and magnetism, and discusses the magneto. Ills. 2800 w. Horseless Age—July 13, 1910. No. 15645.

The Gibaud Magneto. Brief illustrated description. 700 w. Autocar—July 9, 1910. No. 15657 A.

Legislation.

Callan Law Takes Effect in New York August 1, 1910. Gives full text of a new statute regulating the use of motor vehicles on public highways. 7800 w. Com Veh—July, 1910. No. 15299 C.

Military.

The Employment of Mechanical Transport for Military Purposes. H. R. Hayter. Describes various types of vehicles in use, discussing the advantages and disadvantages of steam and internal-combustion engines, and related matters. 9000 w. Jour Roy U S Inst—June, 1910. No. 15287 N.

Motor Efficiency.

The Prediction of Efficiency in Internal Combustion Engines. William D. Ennis. Gives a theoretical estimate with formulae, discussing the importance of a proper mixture and the economy of a wide-open throttle. 2000 w. Automobile—July 28, 1910. No. 16036.

Motor Heating.

An Unlooked-For Reason for Overheating Motors. Thomas J. Fay. Discusses overheating problems of motors, calling attention to the ills of internal incrustation. The spheroidal condition of the water is considered and its effects. 1200 w. Automobile—July 14, 1910. No. 15609.

Motor Incrustation.

Is Cylinder Incrustation Due to Oil or Gasoline Mainly? Albert L. Clough. Aims to open a discussion of the cause of these incrustations, and the part the carburetor may play as the source of the evil. 1800 w. Horseless Age—July 13, 1910. No. 15644.

Motor Location.

Motor-in-Front vs. Motor-Under-Seat Construction. A comparative discussion of the two types, taken from a recent article in a London paper. 2000 w. Com Veh—July, 1910. No. 15300 C.

Motors.

Modern Automobile Practice. First of a series of articles on petrol-driven vehicles with special reference to transmission. The present number reviews leading characteristics of the engine. Ills. 2000 w. Prac Engr—July 8, 1910. Serial. 1st part. No. 15663 A.

Omnibuses.

Daimler 'Bus with Twin Power Plants. James W. Richardson. Illustrated description of a novel public service ve-

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hicle equipped with gasoline-electric power units in duplicate. 2000 w. Com Veh—July, 1910. No. 15298 C.

A New Petrol-Electric Omnibus. Illustrated description of a new omnibus built by the Daimler Co. 1200 w. Engr, Lond—June 24, 1910. No. 15550 A.

Owen.

Owen Cars with Big Wheels and Left-Hand Drive. Illustrated detailed description. 1200 w. Automobile—July 7, 1910. No. 15419.

Springs.

Some Notes on Good Spring Suspensions. David Landau and Asher Golden. Discusses questions relating to vehicle suspension, giving notes and data of good suspensions. 2000 w. Horseless Age—July 20, 1910. No. 15866.

Tire Repairs.

The Automobile Tire Repair Business S. M. Howell. Drawings and suggestions for the work. 3000 w. Horseless Age—July 20, 1910. No. 15867.

Transmissions.

Efficiency of Friction Transmission. Benjamin F. Bailey. Gives results obtained by mathematical calculation. 2200 w. Horseless Age—July 6, 1910. No. 15491.

Valveless.

The 25 H. P. Valveless Car. Illustrated description of this car which has undergone considerable alteration in the design of both engine and chassis. 1000 w. Autocar—June 25, 1910. No. 15506 A.

Vulcan.

The 15.9 H. P. Vulcan Car. Illustrated description of a new model. 1500 w. Autocar—July 2, 1910. No. 15507 A.

Wind Screens.

A Few Facts on Wind-Screen Efficacy. Diagrams and descriptions of experiments. 2000 w. Auto Jour—July 16, 1910. No. 15887 A.

Some Typical Wind-Screen Designs and Their Respective Merits. Illustrations and explanatory comments. 3000 w. Auto Jour—July 9, 1910. No. 15656 A.

COMBUSTION MOTORS.

Aeronautic Motors.

The Arrangement of Valves in Aeroplane Engines. Considers the conditions to be satisfied in a perfect valve arrangement for these engines. Ills. 2200 w. Engng—June 10, 1910. No. 15496 A.

Some Recent Light Aeroplane Engines. Roy Lindsay. Illustrates and describes types. 3000 w. Horseless Age—July 13, 1910. No. 15646.

Some Light Weight Motors from Europe. Illustrated descriptions. 3000 w. Automobile—July 28, 1910. No. 16040.

Aeronautic Motors and an Aerial Cruiser (Moteurs aéronautiques et Croiseur aérien). J. A. Farcot. Describes a new motor and dirigible developed by the author. Ills. 1800 w. Bul Soc d'Encour—May, 1910. No. 15714 G.

Gas-Engine Cycles.

A Regenerator Cycle for Gas Engines Using Sub-Adiabatic Expansion. A. J. Frith. Describes these regenerative cycles and discusses defects, and calls attention to a new regenerator cycle with sub-adiabatic expansion which promises unusual results. Ills. 4500 w. Jour Am Soc of Mech Engrs—July, 1910. No. 15840 F.

Gas-Engine Indicators.

The Okill Pressure Indicator. Illustrated description of an indicator for ascertaining the pressures in the cylinders of gas-engines. 1000 w. Mech Engr—June 24, 1910. No. 15535 A.

Gas Engines.

The Ruston-Proctor Engines at the Brussels Exhibition. Describes some of these semi-portable engines, illustrating two of them. 1000 w. Engng—July 1, 1910. No. 15544 A.

Portable Suction Gas Engine. Illustrates and describes an 18 B. H. P. portable suction gas engine, stating the advantages claimed over the steam engine. 600 w. Engr, Lond—July 15, 1910. No. 15979 A.

Gas Engines and Gas Producers (Les Moteurs à Gaz et les Gazogènes à Gaz pauvre). M. Letombe. A general review of their construction and applications. Ills. 10000 w. Tech Mod—June, 1910. (Sup.) No. 15721 D.

See also Engines, under MECHANICAL ENGINEERING, STEAM ENGINEERING.

Gas Power Plants.

Pipe Lines, Etc., for Gas Engines. Gives a few empirical formulae for the diameters of various pipe lines in gas-engine installations for meter capacities and gas-bag dimensions and general rules. 1500 w. Mech Wld—June 24, 1910. No. 15534 A.

See also Blast-Furnace Gas, under MINING AND METALLURGY, IRON AND STEEL.

Gas Producers.

The Akerlund Bituminous Gas Producer. Illlustrated detailed description of a suction down-draft, grateless generator and novel cleaning apparatus. 1200 w. Ir Age—July 7, 1910. No. 15308.

Gas Producers (Ueber Gaserzeuger). J. Hofmann. Read at the Düsseldorf Congress. A review of their development and a description of types now in use. Ills. 7500 w. Stahl u Eisen—June 15, 1910. No. 15771 D.

See also Gas Engines, under COMBUSTION MOTORS.

Gas Turbines.

The Cooling of Gas Turbines (Ueber die Kühlung von Gasturbinen). W. Gentsch. Illustrates a number of cooling devices and methods. 5000 w. Die Turbine—June 20, 1910. No. 15910 D.

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Ignition.

Ignition in Gas and Gasolene Engines. Carl Pfanstiehl. A study of the jump spark. 2500 w. Naut Gaz—July 14, 1910. Serial. 1st part. No. 15618.

Dry Batteries. H. S. Green. Read before the Nat. Gas & Gasoline Eng. Trds. Association. Brief discussion of the care of cells and wiring, method of making connections, rate of discharge, and time allowed for recuperation. 1700 w. Naut Gaz—July 14, 1910. No. 15616.

Oil Engines.

Some Test Figures from an Oil Engine. F. J. Kean. Abstract of a paper read before the Inst. of Marine Engrs., at the Japan-British Exhibition. Gives results of tests with conclusions. 1400 w. Mech Engr—July 1, 1910. No. 15532 A.

Test of a 170-H. P. Oil Engine. H. P. Macdonald. Gives data obtained from the operation of an engine in Jersey City, N. J. Ills. 1000 w. Elec Wld—June 30, 1910. No. 15358.

Producer Gas.

Producer Gas Power. L. F. Burger. Read before the Nat. Gas & Gasoline Eng. Trds. Assn. Explains what producer gas is, and briefly reviews its use for power. 1800 w. Naut Gaz—July 14, 1910. No. 15617.

HEATING AND COOLING.

Air Humidifying.

Humidity, Its Necessity and Benefits. W. W. Brand. Remarks on the need of educating the public, the effect of dry air in rooms, etc. Discussion. 3500 w. Heat & Vent Mag—July, 1910. No. 15813.

Air Conditioning Apparatus, Its Construction and Application. W. H. Carrier. Illustrates and describes types of air washers, humidifiers, etc., for controlling the condition of the air in shops, mines, etc. General discussion. 8000 w. Pro Engrs' Soc of W Penn—July, 1910. No. 15988 D.

Central Plants.

Central Station Steam Heating. A. D. Spencer. Abstract of a paper read before Nat. Dist. Heat. Assn. Description and operating cost details of a live-steam central-station heating system and an exhaust-steam central-station heating system in Detroit, Mich. 2000 w. Power—July 5, 1910. No. 15323.

Fans.

See Turbines, under STEAM ENGINEERING; and Ventilation, under MINING AND METALLURGY, MINING.

Federal Buildings.

Heating and Ventilation of Federal Buildings. Nelson S. Thompson. Read before the Am. Soc. of Heat. & Vent. Engrs. Statement of method of choosing type of system and proportioning parts. 1500 w. Met Work—July 16, 1910. Serial. 1st part. No. 15580.

Hot-Air Heating.

Warm-Air Heating Analyzed. R. S. Thompson. Explanation of fundamental ideas of furnace heating, discussing details. 3000 w. Met Work—July 16, 1910. Serial. 1st part. No. 15579.

Refrigeration.

The Cycle of Refrigeration. J. R. Wharton. A study of the cycle in the pressure-volume diagram, also in the temperature-entropy diagram. 7800 w. Ice & Refrig—July, 1910. No. 15290 C.

Steam Heating.

Air-Venting Steam Heating Systems. Charles L. Hubbard. Discusses the location of air valves for the satisfactory removal of air. Ills. 1000 w. Met Work—July 9, 1910. No. 15445.

Ventilation.

The Ventilation of Dwellings (Die Durchlüftbarkeit der Wohnungen). Siegfried Sitte. Discusses the arrangement and construction of dwellings with a view to ventilation requirements. Ills. 3000 w. Zeit d Oest Ing u Arch Ver—June 10, 1910. No. 15926 D.

HYDRAULIC MACHINERY.

Centrifugal Pumps.

De Laval High Efficiency Centrifugal Pumps. Illustrated article considering the principles of design and their selection for various services. 3500 w. Ir Age—July 7, 1910. No. 15306.

Messrs. Gebr, Stork & Co.'s Exhibits at the Brussels Exhibition. Illustrated description of a five-stage high-pressure electrically-driven centrifugal pump for mine drainage. 800 w. Engng—July 15, 1910. No. 15972 A.

New Pumps of the Pontaniou Graving Dock at the Brest Arsenal (Nouvelles Pompes d'Epuisement des Formes de Radoub de Pontaniou à l'Arsenal de Brest). Describes an installation of three Rateau pumps. Ills. 2000 w. Génie Civil —June 11, 1910. No. 15736 D.

See also Turbines, under STEAM ENGINEERING.

Electric Pumping.

Electricity in Irrigation. Illlustrated description of the electric irrigation pumping plant of the Mosida Fruit Lands Co. in Utah. 1800 w. Elec Wld—July 21, 1910. No. 15826.

Electric Pumping for Irrigation. Alton D. Adams. Explains the necessity of pumping water for irrigating many sections, and illustrates the three ways that electric pumping is applied. 2000 w. Elec Wld—June 30, 1910. No. 15357.

Electric Pumping in California. Alton D. Adams. A report of the extensive use of the electric system in pumping for irrigation. 1500 w. Elec Wld—July 28, 1910. No. 16021.

Electric Pumping in Holland. Illustrates and describes methods adopted in

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reclamation work at the Maas Estuary. 1000 w. Elec Rev, N Y—July 9, 1910. No. 15487.

Presses.

See Forging Presses, under MACHINE WORKS AND FOUNDRIES.

Rams.

Hydraulic Rams and Their Capacity. N. A. Carle. Charts for calculating the efficiency of rams with explanation of their use. 1000 w. Power—July 5, 1910. No. 15324.

Turbines.

Hydraulic Turbines for 670-Foot Head. H. Birchard Taylor. Illustrated description of two hydraulic reaction turbines for Mexico. 3000 w. Power—July 5, 1910. No. 15321.

Turbine Tests.

Acceptance Tests on Two Turbines Built by A. Riva & Co., Milan (Esperienze di Collaudo su due Turbine a Spirale della Casa Ing. A. Riva & C.—Milano). G. Ghersina. Describes the installation and the tests and gives results. Ills. Serial. 1st part. 1000 w. Industria—June 19, 1910. No. 15757 D.

Water Hammer.

Water Hammer in Conduits (Les Coups de Bélier dans les Conduites d'Eau). A. Rateau. A mathematical discussion of its causes and effects. Ills. 7500 w. All Indus—June, 1910. No. 15727 D.

Water Wheels.

The Efficiency of Water-Wheels. Henry D. Jackson. Explains how the unusually high efficiencies given by builders are obtained, with suggestions for making efficiency tests. 1800 w. Power—July 26, 1910. No. 15982.

MACHINE ELEMENTS AND DESIGN.

Annular Rings.

Deformations of Elastic Rings (Déformations d'un Cercle élastique). M. Bonneau. A mathematical discussion of the deformations of rings under radial stress. Ills. 4000 w. Ann d Ponts et Chaussées—1910—III. No. 15744 E + F.

Bearings.

An Unusual Roller Thrust Bearing. T. F. Salter. Illustrated description of a large thrust bearing for a steel mill, providing roller surfaces for 2,250,000 pounds load. 10000 w. Am Mach—Vol. 33. No. 28. No. 15585.

Clutches.

Some Points Regarding Disc Clutches. F. E. Watts. Brief illustrated description of the elementary principles of the disc clutch. 2500 w. Horseless Age—June 29, 1910. No. 15310.

Conversion Formulae.

Standardized Formulae for Ready Reference. Thomas J. Fay. Deals with simplified conversion formulae. 1500 w. Automobile—July 28, 1910. No. 16038.

Drawings.

New Method for Base Line Drawings. H. E. Goldberg. Explains the weaknesses of present methods, and the development of a new method. Ills. 3000 w. Am Mach—Vol. 33. No. 30. No. 16010.

Filing Systems.

See same title, under INDUSTRIAL ECONOMY.

Gears.

Spiral Gear Problem Solutions. A. E. Thayer. Gives mathematical solutions not generally well known with natural functions of angles, secants, and co-secants. 3500 w. Am Mach—Vol. 33. No. 29. No. 15699.

Gyroscope.

Elementary Theory of the Gyroscope. E. H. Barton. Treats a simple fundamental case of gyroscopic motion, employing only the elementary conceptions of mechanics and the calculus. 1200 w. Engng—June 24, 1910. No. 15537 A.

See also Monorail, under STREET AND ELECTRIC RAILWAYS.

Punch Frames.

Properties and Sections for Punch and Shear Frames. Alton L. Smith. Tables and explanation of a method of simplifying the work of selecting proper sections for punch and shear frames. 800 w. Mach, N Y—July, 1910. No. 15379 C.

Springs.

The Design of Flat Spiral Springs. L. J. Butzow. An exposition of the principles entering into the calculation of this class of springs, giving the most important equations deduced. 1200 w. Mach, N Y—July, 1910. No. 15370 C.

MACHINE WORKS AND FOUNDRIES.

Bending Machines.

Bending Machine for 80-Millimetre Angle Iron (Machine zum Biegen von Winkeleisen bis 80 x 80 mm. Schenkellänge). Franz Brzoska. Describes in detail a machine built by the author at Ratibor, Germany. Ills. Serial. 1st part. 1000 w. Elektrotech Rundschau—June 23, 1910. No. 15941 D.

Blacksmith Shops.

A Large Blacksmith Shop Using Oil Fuel Exclusively. Holden A. Evans. Describes the smith shop at the Mare Island navy yard and its liquid fuel equipment. Ills. 5000 w. Ir Trd Rev—July 14, 1910. Serial. 1st part. No. 15607.

Boiler Making.

Practical Notes on Boilermaking. J. E. Lawrence. Notes for those engaged in boiler construction and design, arranged mainly in the order in which the operations take place. Ills. 2500 w. Mech Wld—June 24, 1910. Serial. 1st part. No. 15533 A.

Boring Machines.

Primitive Boring Machines. Joseph G. Horner. Drawings and description of a

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machine shown in a French encyclopedia (1777), for boring a cannon. 600 w. Mach, N Y—July, 1910. No. 15374 C.

The Rochester Horizontal Boring Machine. Illustrates and describes a new standard tool for horizontal boring, drilling, tapping and milling. 1500 w. Ir Age—June 30, 1910. No. 15302.

Brass Founding.

The Production of the "Heat-Black Finish" on Brass, Bronze and Copper. Gives the solutions, method of applying and final treatment. 1000 w. Brass Wld—July, 1910. No. 15687.

Fluxes Used in the Brass Foundry. Irwin S. Sperry. Read before the Am. Brass Found. Assn. Describes fluxes that have proved valuable for aluminum, nickel, copper, brass, bronze or composition, German silver, etc., and the manner in which they should be used. 3000 w. Am Mach—Vol. 33. No. 27. No. 15441.

Can-Making Machines.

Automatic Can Making Machinery. Illustrated descriptions of machines for automatically forming, seaming, soldering, heading and hemming. Also a testing machine to discover leaks. 2000 w. Am Mach—Vol. 33. No. 27. No. 15437.

Castings.

The Shrinkage of Cast Iron (Ueber das Schwinden des Gusseisens). H. Vetter. Discusses its causes and effects, methods of making allowances for it, etc. 2500 w. Stahl u Eisen—June 1, 1910. No. 15766 D.

See also Cast Iron, under MATERIALS OF CONSTRUCTION.

Chip Briquetting.

Briquetting Iron and Steel Chips. Hubert Hermans. Describes a process developed in Germany for utilizing chips. 2200 w. Am Mach—Vol. 33. No. 27. No. 15439.

Coil Winder.

Winding Flat Copper Strip Coils. Illustrated description of a device for winding electric coils of flat strip copper. 1200 w. Am Mach. Vol. 33. No. 29. No. 15698.

Cores.

Tinned Core Supports and Some Tests with Supports Containing Lead (Ueber den Begriff "handelsüblich verzinnte Kernstützen" und einige Versuche mit bleihaltigen Kernstützen). F. Westhoff. A brief discussion of the cost of core-support materials. Discussion. Ills. 2000 w. Stahl u Eisen—June 1, 1910. No. 15765 D.

Cupola Practice.

A Substitute for Pine Wood in Starting Cupolas (Die Frage eines Ersatzes von Kiefernscheitholz zum Anheizen der Kupolöfen). O. Henning. Suggests the use of an oil or gas flame for igniting the coke. Discussion. Ills. 2000 w. Stahl u Eisen—June 1, 1910. No. 15764 D.

The Removal of Difficulties in Tapping Cupolas (Ueber den Kupolofen-Abstich und seine Beseitigung). Describes a tipping fore-hearth, its advantages and operation. Ills. 1300 w. Giesserei-Zeit—June 1, 1910. No. 15781 D.

Dies.

Operation and Construction of the Sub-Press Die. Roy Plaisted. Illustrated description. 1500 w. Mach, N Y—July, 1910. No. 15380 C.

Drilling.

Drill Press Work on Screw Machine. S. H. Bacon. Describes a method of performing cross-drilling operations on a special piece of work with the spindle controlled in an unusual manner. Ills. 800 w. Am Mach—Vol. 33. No. 27. No. 15435.

Drilling Machines.

High Power Drilling Machines. Illustrates and describes a machine designed for high duty and rapid work, reporting tests. 1000 w. Am Mach—Vol. 33. No. 26. No. 15336.

Enamelling.

The Constituents of Enamelling Glaze and Their Properties (Die Hauptbestandteile der Emailleglasur und deren Eigenschaften). J. Schlemmer. Practical notes on the materials used in enamelling. Serial. 1st part. 1400 w. Giesserei-Zeit—June 1, 1910. No. 15782 D.

Forging.

A Few Forging Operations. Ethan Viall. The practice in the C., H. & D. R. R. shop, Lima, Ohio, is illustrated and described. 700 w. Mach, N Y—July, 1910. No. 15378 C.

Forging Presses.

The Hydraulic High-Speed Forging Press. Illustrated description of the Davy forging press, as manufactured at Pittsburg. 2500 w. Ir Trd Rev—July 21, 1910. No. 15821.

A High Speed Hydraulic Forging Press. Illustrated description of the type built by the United Engineering & Foundry Co. 1200 w. Ir Age—June 30, 1910. No. 15303.

Foundries.

Foundry for Casting Transformers. Illustrates and describes methods and apparatus used in the new foundry of the General Electric Company, at Pittsfield, Mass. 1200 w. Am Mach—Vol. 33. No. 30. No. 16007.

Foundry Coke.

Coke for Foundry Purposes. E. L. Rhead. Read before the British Found. Assn. Discusses conditions affecting the quality of the coke, and related subjects. 3000 w. Engng—July 15, 1910. No. 15975 A.

Foundry Furnaces.

The Construction of Crucible Furnaces. Walter J. May. An illustrated article giving detailed directions for the construction of such furnaces. 2500 w. Mech Wld—July 8, 1910. No. 15668 A.

We supply copies of these articles. See page 966.

Galvanizing.

A New Process (Spray Process) for the Production of Metallic Coatings. M. U. Schoop. Describes this new process; the essential features are that metal in liquid and highly heated condition is sprayed onto the surface to be coated. 2300 w. Met & Chem Engng—July, 1910. No. 15426 C.

Gear Cutting.

Determining Dimensions of Gears from Samples. E. Winslow Baxter. Explains methods of duplicating worn out or broken gears. 800 w. Mach, N Y—July, 1910. No. 15373 C.

Machining Bevel Pinion Blanks. C. L. Goodrich. The bevel surfaces are machined to the correct angle by means of an angular turning fixture carried by the turret. Ills. 800 w. Am Mach—Vol. 33. No. 30. No. 16008.

Punch and Die for Elliptic Gears. W. J. McDevitt. Describes the method of calculating laying out and making the punch and die for this work. 800 w. Mach, N Y—July, 1910. No. 15372 C.

Large Double-Headed Gear-Cutting Machine. Illustrated description of a machine for cutting large double helical gears. 700 w. Engr, Lond—July 8, 1910. No. 15684 A.

Grinding.

Grinding Economy. H. Darbyshire. A criticism of a statement in Mr. Thacher's article on "Economy in Grinding," and a discussion of the economic side of the grinding question. 2500 w. Mach, N Y—July, 1910. No. 15381 C.

Grinding Machines.

History of the Invention of the Universal Grinding Machine. Luther D. Burlingame. An illustrated account of its development from the crude grinding lathe used in the early 60's. 1500 w. Mach, N Y—July, 1910. No. 15369 C.

The Thompson Universal Grinder. Illustrated description of a machine for all kinds of grinding. 1000 w. Ir Age—June 30, 1910. No. 15301.

Lathes.

Cone vs. Geared Drive. R. K. LeBlond. Read before the Nat. Machine Tool Blds' Convention. An examination of the efficiency of the two methods and the advantages of each. 2500 w. Mach, N Y—July, 1910. No. 15377 C.

Modern Car-Wheel Turning. Walter L. Clark. Illustrates and describes improved wheel lathes, and the large output made possible. 2000 w. Cassier's Mag—July, 1910. No. 15647 B.

Pond Car Wheel Lathe with Pneumatic Attachments. Illustrated description. 700 w. Mach (Ry. Ed.)—July, 1910. No. 15384 C.

Machine Tools.

See Management, under MACHINE WORKS AND FOUNDRIES.

Molding.

Cylinder Moulding for Railway Engines. H. Pemberton. Read before the Birmingham branch of the British Found. Assn. Illustrated description of methods used for the three types in most common use on the Midland Ry., the twin cylinders, the piston valve, and the high-pressure cylinder of the compound cylinder engine. 3500 w. Ir & Coal Trds Rev—July 8, 1910. No. 15685 A.

Molding a Spiral Turbine Casing (Formen eines Spiralgehäuses von rundens, gleichmässig zunehmendem Querschnitt mittels Modellgerippe). N. Ifkowitsch. Describes the tools and methods used. Ills. 2500 w. Giesserei-Zeit—June 15, 1910. No. 15784 D.

Molding Sand.

Coal Dust in Molding Sand (Der Kohlenstaub im Formsand und seine Bewertung). C. Henning. Discusses its effects and advantages. Discussion. 3200 w. Stahl u Eisen—June 1, 1910. No. 15763 D.

Pipe Founding.

Machine-Made Molds for Casting Pipes on End. R. Ardelt, in *Stahl u Eisen*. Illustrates and describes various devices tried, pointing out their defects, and illustrating the machine invented by the author which is believed to meet all requirements. 3000 w. Ir & Coal Trds Rev—July 1, 1910. No. 15568 A.

Planers.

Discussion of Planer Feeds. E. H. Fish. Shows that the split-ring friction is not as great a saver of power as is sometimes claimed, and explains the design of a positive rachet feed for severe service. 1500 w. Am Mach—Vol. 33. No. 30. No. 16009.

Press Work.

Making Aluminum Gas Tips. Illustrates and describes the machine and tools used in the work. 1000 w. Am Mach—Vol. 33. No. 26. No. 15337.

Manufacturing a Novel Jar Cap. Frank A. Stanley. An illustrated account of the press equipment and operating details. 1500 w. Am Mach—Vol. 33. No. 29. No. 15694.

Saws.

The Newton 26-In. Cold Saw Cutting-Off Machine. Illustrated description of a high speed machine with a new feed-changing mechanism. 700 w. Ir Age—July 14, 1910. No. 15576.

Sheet-Metal Work.

Automobile Sheet Metal Patterns. William Neubecker. Illustrated article on patterns for different parts of the work, with various methods of constructing seams and joints. 1200 w. Met Work—July 2, 1910. Serial. 1st part. No. 15289.

Shop Appliances.

Jigs and Fixtures for Candy Machines. Illustrates and describes jigs and fixtures

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for close drilling. 1200 w. Am Mach—Vol. 33. No. 29. No. 15693.

Shop Heating.

The Heating, Ventilating and Air-Conditioning of Factories. Percival Robert Moses. The first of two articles reviewing the present practice as to temperature, humidity and purity. Ills. 5000 w. Engineering Magazine—August, 1910. No. 16002 B.

Shop Heating by Direct Radiation. Charles L. Hubbard. On the proper methods of installing and operating a system of this kind. Ills. 4500 w. Mach, N Y—July, 1910. No. 15371 C.

The Heating and Ventilation of Industrial Buildings (Le Chauffage et la Ventilation des Bâtiments industriels). A complete treatise on this subject. Ills. 80000 w. Tech Mod—June, 1910. (Sup.) No. 15726 F + F.

Shop Lighting.

Industrial Lighting with Incandescent Lamps. J. D. Hoit, P. F. Bauder, and H. S. Hall. Abstract of paper read before the Nat. Elec. Lgt. Assn. Briefly discusses the systems employed for satisfactory artificial illumination, reporting various plants visited where new methods have been introduced. 1500 w. Eng News—July 14, 1910. No. 15589.

Shop Practice.

Precision in Instrument Making. Illustrates and describes methods of extreme accuracy used in the manufacture of standard scientific instruments. 3000 w. Am Mach—Vol. 33. No. 27. No. 15440.

Methods in Making Transformer Coils. Machines used and methods of manufacture and testing are illustrated and described. 600 w. Am Mach—Vol. 33. No. 27. No. 15438.

Automobile Factory Practice. Ethan Viall. Illustrated description of methods used at the Olds Motor Works, Lansing, Mich. 1200 w. Mach, N Y—July, 1910. No. 15375 C.

Making the Atlas Motor Car. Snowden B. Redfield. Illustrates and describes work requiring careful boring, keying, and alining. 2000 w. Am Mach—Vol. 33. No. 27. No. 15434.

Work on Complicated Brass Valve. H. P. Cathcart. Illustrates and describes the different operations in machining the various parts, and the devices used. 1500 w. Am Mach—Vol. 33. No. 27. No. 15436.

Shop Kinks. Illustrates and describes labor-saving devices used in the shops of the Chicago & North-Western. 2500 w. Ry Age Gaz—July 1, 1910. No. 15363.

Shops.

The Brewster Shops of the Wheeling & Lake Erie. Plan and illustrated description of the shops and their equipment. 2200 w. Ry Age Gaz—July 1, 1910. No. 15364.

The Works of Messrs. W. T. Glover and Co. Limited, Trafford Park, Manchester. Illustrated detailed description of works for the manufacture of electric cables and appliances for their installation. 2000 w. Col Guard—June 24, 1910. Serial. 1st part. No. 15536 A.

Shop Ventilation.

Ventilation and Dust Removal in Cotton Mills. Discusses methods of improving the hygienic conditions in card rooms and gassing rooms. Ills. 1500 w. Prac Engr—June 24, 1910. Serial. 1st part. No. 15526 A.

See also Shop Heating, under MACHINE WORKS AND FOUNDRIES.

Welding.

German Electric Welding Machines. Bruno Loewenherz. Illustrates and describes a variety of machines, of the resistance type, for manufacturing metal articles. 2000 w. Am Mach—Vol. 33. No. 26. No. 15339.

Wire Drawing.

The Wire Rod Mills of Wm. Cooke & Co. Limited, at the Tinsley Steel, Iron, and Wire Rope Works, Tinsley, Near Sheffield. Illustrated detailed description of new works and their equipment. 3000 w. Ir & Coal Trds Rev—July 1, 1910. No. 15570 A.

MATERIALS OF CONSTRUCTION.

Alloys.

German Silver for Casting Purposes. A. Napier. From *Foundry Trade Jour.* Discusses copper-nickel-zinc mixtures and their use. 1500 w. Mech Engr—July 8, 1910. No. 15667 A.

Alloy Steels.

Various Effects of Titanium on Steel. E. F. Lake. Information concerning this new alloying material and its effects. 1800 w. Am Mach—Vol. 33. No. 30. No. 16013.

See also Locomotive Construction, under MATERIALS OF CONSTRUCTION.

Bearing Metals.

Bearing Metals. A. Hague. Considers points of importance in choosing an alloy for bearing purposes, and discusses rigid bronzes, plastic white metals, and plastic bronzes. Ills. 8000 w. Engng—June 24, 1910. No. 15539 A.

Bronzes.

Determination of the Coefficient of Equivalence in the Case of Special Bronzes (Détermination du Coefficient d' Equivalence dans le Cas des Bronzes spéciaux). L. Guillet and L. Révillon. Reports a research on the influence of foreign elements on copper-tin alloys. Ills. 1500 w. Rev de Métal—June, 1910. No. 15710 E + F.

Cast Iron.

Chemical Standards for Gray Iron. John Jermain Porter. Presented at meeting of Am. Found. Assn. Summary of

a report giving analysis of a wide range of iron castings including recommendations for standard chemical properties. 5000 w. Foundry—July, 1910. No. 15312.

Some Recent Tests of Cast Iron. Alexander E. Outerbridge, Jr. Read before the Am. Soc. for Test. Mat. Deals with the sensitiveness of cast iron to cooling influences. 900 w. Ir Age—July 7, 1910. No. 15307.

Segregation in Cast Iron (Ueber Entmischung von Gusseisen). H. Adammer. Gives a number of examples from actual practice. Discussion. Ills. 7000 w. Stahl u Eisen—June 1, 1910. No. 15762 D.

Breaking-Stress Formulae (Knickformeln). Th. Scharff. A comparison of various formulae for cast iron and other materials. Ills. Serial. 1st part. 1200 w. Deutsche Bau—June 1, 1910. No. 15905 B.

Heat Insulation.

Study of Thermal Insulators for Cars. C. R. Harris. A study to determine the efficiency of several thermal insulators when applied to metallic surfaces. Ills. 1000 w. Am Mach—Vol. 33. No. 29. No. 15697.

Metallography.

See Hoisting Ropes, under MINING AND METALLURGY, MINING.

Refractory Materials.

See Blast-Furnace Lining, under IRON AND STEEL.

Steel.

Heat Treatment of Steel. J. F. Springer. Reports scientific researches into the characteristics and behavior of different kinds of steel, and the effects of heating, overheating, etc. 2500 w. Boiler Maker—July, 1910. No. 15583.

Tool Steel.

The Durability of Tool Steel. Editorial on the conclusions of a recent paper by Edward G. Herbert, read before the Iron and Steel Institute. 1800 w. Ry Age Gaz—July 1, 1910. No. 15361.

MEASUREMENT.

Cyclometers.

Driving-wheel Distance Meters (Der dem Fahrrad angeborene Kilometerzähler). Otto Schuch. Describes the method of utilizing the driving wheel as a distance meter in any chain-transmission vehicle. Ills. Serial. 1st part. 1500 w. Elektrotech Rundschau—June 16, 1910. No. 15940 D.

Dynamometers.

The Hopkins Gasolene-Engine Dynamometer and Speedometer. N. Monroe Hopkins. Illustrated detailed description of the apparatus and of experimental work. 1400 w. Jour Fr Inst—July, 1910. No. 15847 D.

Application of the Cradle-Dynamometer to the Testing of Electrical Machinery. J. Davies and F. Shaw. Read before the Manchester Students Sec. of the Inst. of Elec. Engrs. Describes the dynamometer used at the Manchester School of Technology, the cradle being supported on ball bearings instead of the customary knife edges. Gives experiments. Ills. 2200 w. Elect'n, Lond—July 8, 1910. No. 15662 A.

Hardness.

The Hardness Test as an Acceptance Test for Iron and Steel (Impiego delle Prove di Durezza nei Collandi dei Prodotti siderurgici). Gives the results and conclusions of an investigation by the Italian State Railways. Ills. 6000 w. Ing Ferro—June 16, 1910. No. 15759 D.

Laboratories.

Laboratories at University of Toronto. R. W. Angus. Illustrates and describes the mechanical equipment in steam engine, gas engine and hydraulic laboratories. 3000 w. Power—July 26, 1910. No. 15980.

Pyrometry.

Some Applications of Electric Pyrometry (Quelques Applications des Pyromètres électriques). M. Henry. Describes particularly the uses of recording pyrometers. Ills. 2000 w. L'Elecn—June 25, 1910. No. 15719 D.

See also Heating, under ELECTRICAL ENGINEERING, POWER APPLICATIONS.

Rotating Speed.

An Accurate Electrical Method of Measuring Speeds of Rotation. E. B. Brown. A brief description of apparatus employed and method of experiment. 1000 w. Elect'n, Lond—June 24, 1910. No. 15518 A.

Testing Methods.

Inspection and Testing of Cast Iron and Steel. Stanley M. Udale. Suggestions for the testing of raw materials and semi-manufactured materials, entering the factory. Ills. 2000 w. Horseless Age—July 6, 1910. No. 15490.

Torsion Meters.

Some Types of Torsion Meter. Edward P. Buffet. Illustrates and describes various types. 3500 w. Power—July 19, 1910. No. 15654.

Vacuum Gauges.

Vacuum Gauges and Barometric-Vacuum Gauges for Condenser Plants, etc. Illustrates and describes types. 1200 w. Mech Engr—July 15, 1910. No. 15896 A.

Water.

Gauging by Titration (Jaugeages par Titrations). A. Boucher. Application of Chloride Titration to the Measurement of Turbine Discharges (Application de la Titration des Chlorures au Jaugeage de Débits). R. Mellet. Describes fully this method of measuring water. 4000 w. Bul Tech d l Suisse Romande—June 10, 1910. No. 15730 D.

Wheel Testing.

Recent Developments in Wheel Testing at Purdue University. Charles H. Benja-

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min. Describes a testing-pit recently established, and reviews the progress made in experimentation with rotating members. Ills. Also general discussion. 4000 w. Jour Assn of Engng Socs—June, 1910. No. 15986 C.

POWER AND TRANSMISSION.

Belt Driving.

An Unexpected Power Factor. Charles C. Klein. Explains conditions and the cause of an increase in the friction load in a textile mill. 1400 w. Power—July 12, 1910. No. 15444.

Belts.

Leather for Belting Purposes. Frederic Dannerth. Enumerates the processes which transforms the raw hide into the finished belt and gives hints on the use of belt-dressing and the care of belts. 1800 w. Power—July 19, 1910. No. 15652.

Electric Driving.

See Meters, under ELECTRICAL ENGINEERING, MEASUREMENT.

Lubricants.

Selection of Lubricating Oils. Charles B. Arnold. Flash point, specific gravity and viscosity must be carefully considered. 1000 w. Power—July 26, 1910. No. 15981.

Peak Loads.

The Peak-of-the-Load Problem. Editorial discussion of this problem in many engineering industries, with helpful suggestions. 2200 w. Eng News—July 7, 1910. No. 15409.

Turbo-Compressors.

See Turbines, under STEAM ENGINEERING.

STEAM ENGINEERING.

Air Pumps.

Westinghouse-Leblanc Centrifugal Air Pumps with Condensers (Westinghouse-Leblanc Schleuderrad-Luftpumpen mit Kondensatoren). Description, report of tests and performance, and illustrations of installations. 4200 w. Glasers Ann—June 1, 1910. No. 15923 D.

Boiler Economy.

Boiler Fuel Leaks. Edward B. Myers. Read before the Iowa Dist. Gas Assn. Considers the losses incidental to the production of steam, due to the poor design or improper operation of the boiler, and the losses in the distribution or use of the steam. 3000 w. Am Gas Lgt Jour—July 25, 1910. No. 15871.

Boiler Explosions.

Boiler Explosions and Their Causes. G. W. Buckwell. Read before the Barrow & District Assn. of Engrs. Briefly considers the scientific causes, given in the early seventies, to account for boiler explosions, and the present explanations and how to prevent explosions. Gives brief outline of explosions and their causes. 4500 w. Boiler Maker—July, 1910. No. 15581.

Boiler Furnaces.

A Japanese Design of Boiler Furnace. Y. Sekiguchi. Illustrated description of a novel design. 1200 w. Mech Engr—June 24, 1910. No. 15530 A.

Boiler Repairs.

Applying Patches to Boilers. H. S. Jeffery. Shows that the method of repairing depends on the nature and location of the defect. Illustrates and describes various repairs. 2500 w. Power—July 5, 1910. No. 15322.

Boilers.

The Grille Water-Tube Boiler. Illustrated detailed description of a novel type. The utmost stress has been laid on the idea of accessibility. 1400 w. Engr, Lond—July 1, 1910. No. 15565 A.

Boiler Selection.

Selecting a Boiler. F. C. Bitgood. Read before the Ohio Soc. of Mech., Elec., & Steam Engrs. Deals with facts regarding different classes of boilers, pointing out the best way to make a selection for a given service. 2000 w. Boiler Maker—July, 1910. No. 15584.

Boiler Tests.

Test of a Boiler Plant Equipped with Superheaters (Untersuchung einer nachträglich mit Ueberhitzern ausgerüsteten Dampfkesselanlage). Gives results of tests before and after the installation of the superheaters. 2700 w. Glückauf—June 18, 1910. No. 15794 D.

Boiler Tubes.

Permissible Variation of Fire Tubes from the Circular (Zur Frage der zulässigen Abweichungen der Flammrohre von der Kreisform). C. Bach. Discusses the German regulations. Ills. 2300 w. Zeitschr d Ver Deutscher Ing—June 18, 1910. No. 15952 D.

Condensers.

Clean Water for Condensing Purposes. Warren O. Rogers. Illustrated description of a concrete raceway constructed with automatic gateway to supply clean water from a pond. 1000 w. Power—July 12, 1910. No. 15442.

The Surface Condenser in Mine Power Plants. W. A. MacLeod. Gives results of condensation with intermittent prime movers. 2200 w. Eng & Min Jour—July 16, 1910. No. 15623.

Development of the Leblanc Condenser in America. R. N. Ehrhart. Gives a detailed description of the Leblanc air pump in connection with the condenser. Ills. 1200 w. Elec Jour—July, 1910. No. 15851.

See also Vacuum Gauges, under MEASUREMENT.

Engine Cranks.

Crank Troubles. Hints on dealing with various crank troubles. 1200 w. Elec Rev, Lond—June 24, 1910. No. 15514 A.

Engine Foundations.

Concrete for Machinery Foundations. G. Wise. Considers the material used,

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mixing, forms, pouring and finishing. 1800 w. Power—July 26, 1910. No. 15983.

Engine Lubrication.

See Steam Engines, under MARINE AND NAVAL ENGINEERING.

Engines.

The Revival of the Reciprocating Steam Engine. R. J. S. Pigott. This second of two articles discusses practical applications and the calculating of an engine-turbine combination for a given case. Ills. 3500 w. Engineering Magazine—August, 1910. No. 16003 B.

The Stumpf Uni-Directional-Flow Engine. Prof. J. Stumpf. Abridged translation of a communication on a type of engine first known through a British patent granted to Leonard Jennett Todd, under the title of "Mid-Cylinder Exhaust Engines." Claims remarkable advantages for this type of exhaust rendering it particularly valuable for engines using superheated steam. Ills. 4500 w. Engng—June 10, 1910. No. 15501 A.

Compound Engine with Müllerdrop-Valve Gear of the Zwickauer Maschinenfabrik (Machine à Vapeur compound à Distribution par Soupapes, système Müller, de la Zwickauer Maschinenfabrik). F. Hofer. Illustrated description. 2000 w. Génie Civil—June 25, 1910. No. 15740 D.

Prime Movers at the Brussels Exhibition (Der Kraftmaschinenbau auf der Weltausstellung in Brüssel 1910). H. Dubbel. A preliminary report on the gas-engine, steam-engine and steam-turbine exhibits. Ills. 2500 w. Zeitschr d Ver Deutscher Ing—June 18, 1910. No. 15949 D.

Engine Testing.

Engine Erecting and Testing Pits. H. Pearman. Considers the requirements in pits suitable for the erection and testing of reciprocating engines. Ills. 800 w. Mech. Wld—July 8, 1910. Serial. 1st part. No. 15669 A.

Flue-Gas Analysis.

How to Make a Flue-Gas Analysis. Julian C. Smallwood. Description of Orsat flue-gas analyzing apparatus and the method of operation. Directions for preparing chemical solutions used in the apparatus, and suggestions on errors which influence the accuracy. 3000 w. Power—July 9, 1910. No. 15651.

Fuels.

The Influences of the Volatile Constituents in Coal Combustion. Editorial review of tests conducted by Prof. E. J. Constam and Dr. P. Schläpfer and described in the *Zeit. des Ver. Deut. Ing.* 2000 w. Engng—July 15, 1910. No. 15974 A.

Mechanical Stokers.

Notes on Western Anthracite Coal. A. G. Christie. Confirms the belief that some types of mechanical stokers are better adapted than others to burn certain kinds of coal, and refers particularly to the Roney stoker. 3000 w. Power—July 19, 1910. No. 15653.

Front Feed Automatic Stokers. J. F. Springer. Illustrates and describes types, explaining their operation. 3000 w. Power—July 12, 1910. No. 15443.

Rotary Engines.

Modern Rotary Steam Engines. Warren O. Rogers. An illustrated study of the construction of several makes of this type of engine. 3500 w. Power—July 5, 1910. No. 15326.

Smoke Prevention.

Smoke Abatement: Two Typical Reports. John B. C. Kershaw. Gives a brief résumé of these two reports, with editorial comment. 2500 w. Elec Rev, Lond—July 15, 1910. No. 15890 A.

Chicago's Smoke Problem. Paul P. Bird. A general paper on this subject, introducing a discussion. 26800 w. Jour W Soc of Engrs—June, 1910. No. 15854 D.

Smoke Recorders.

The Wattles Stoking Register. Illustrates and describes an apparatus which gives photographically a 24-hour record of smoke density in chimneys. 1000 w. Ir Age—July 21, 1910. No. 15801.

Stacks.

Chimneys and Draft. John S. Leese. Considers the temperature at which maximum draft is secured, and gives formula for estimating the drafts which a given chimney is capable of developing. 1200 w. Power—July 5, 1910. No. 15327.

Steam Pipes.

Resistance to Pressure of Oval Pipes (Résistance des Tuyaux ovales soumis à des Pressions). M. Westphal. Translated from the *Zeitschr. d. Ver. Deutscher Ing.* for July 24, 1909. Ills. 2500 w. Rev. de Mécan—June, 1910. No. 15717 E + F.

Steam Properties.

Alignment Chart for Determining Specific Volumes of Steam. William J. Goudie. Gives a chart designed to reduce the labor of calculation when volumes cannot be obtained directly from the tables, explaining its use. 1000 w. Engng—July 1, 1910. No. 15542 A.

Superheating.

Superheaters (Quelques Surchauffeurs). A review of superheating devices recently patented and described. Ills. 6000 w. Rev de Mécan—June, 1910. No. 15718 E + F.

See also Boiler Tests, under STEAM ENGINEERING.

Turbine Design.

High-Speed Steam-Turbine Rotor Design and Construction. John McKenzie Newton. Read before the Jr. Inst. of Engrs. Discusses the mechanical design and construction of the rotors of such turbines, especially the mechanical strength and stiffness in relation to the materials. Ills. 8000 w. Engng—July 8, 1910. Serial. 1st part. No. 15678 A.

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Diagrams for the Investigation of Turbine Rotors (Ein ereweitertes Diagramm mit verschiedenen Wirkungsgraden für die Teilturbinen und dessen Anwendung zur Untersuchung von Laufrädern). C. Reindl. Mathematical. Ills. Serial. 1st part. 2000 w. Zeitschr f d Gesamte Turbinenwesen—June 30, 1910. No. 15915 D.

Turbine Governing.

The Indirect Intertia Governor (Der indirekt wirkende Beharrungsregler). D. Thoma. Discusses its application to hydraulic turbines. Ills. 1500 w. Zeitschr f d Gesamte Turbinenwesen—June 20, 1910. No. 15913 D.

Turbine Plants.

Brush-Parsons Exhaust Turbines. Illustrated detailed description of an exhaust-turbine plant installed in Belfast. 3500 w. Engng—July 1,1910. No. 15541 A.

The Exhaust-Steam Turbogenerator Plant at the "Fröhliche Morgensonne" Mine (Die Abdampf-Turbogeneratoranlage auf Zeche "Fröhliche Morgensonne"). Illustrated description. 2000 w. Zeitschr f d Gesamte Turbinenwesen—June 10, 1910. No. 15911 D.

Turbines.

Small Steam Turbines. John Gurney Callan. Considers the general type best suited to small units, and the mechanical arrangement most advantageous. Ills. 4000 w. Jour Assn of Engng Socs—June, 1910. No. 15987 C.

The Utilization of Exhaust Steam. Herman Niemetz. On the advantages of exhaust-steam turbines. Ills. 1500 w. Elec Wld—July 7, 1910. No. 15486.

Atmospheric or Low Pressure Turbines. J. A. MacMurchy. An illustrated article explaining the advantages of these turbines. 1700 w. Can Elec News—July, 1910. No. 15447.

I. Exhaust Steam Turbines and Condensing Plant at McDonald Road Station. Frank A. Newington. II. Extensions to Existing Electricity Supply Stations by Means of Mixed Pressure Turbines. Ashton Bremner. Two papers before the Munic. Elec. Assn., discussed together. 6000 w. Elec Engr, Lond—June 24, 1910. No. 15511 A.

The New Tosi Steam Turbines (Die neueren Dampfturbinen der Firma Franco Tosi, Legnano). W. Gensecke. Illustrated detailed description. Serial. 1st part. 1700 w. Zeitschr f d Gesamte Turbinenwesen—June 30, 1910. No. 15914 D.

Multi-Stage Turbo-Machines and Recent Applications (Les Turbo-Machines multicellulaires et leurs récentes Applications). A. Rateau. Discusses steam turbines, centrifugal pumps, fans and compressors. Ills. 13000 w. Mem Soc Ing Civ de France—April, 1910. No. 15702 G.

A Description of Some Turbo-Machines and a Comparison with the Corresponding Piston Machines (Description de quelques Turbo-Machines et Comparaisons de Celles-ci avec les Machines à Piston correspondantes). A. Barbezat. Deals with centrifugal pumps of the Société de la Meuse, Rateau turbo-compressors, and Barbezat steam turbines. Ills. 15000 w. Mem Soc Ing Civ de France—April, 1910. No. 15703 G.

Some Notes on Turbo-Machines (Quelques Remarques sur les Turbo-Machines). J. Rey. A brief review of the evolution of steam turbines, centrifugal pumps and compressors. Ills. 8000 w. Mem Soc Ing Civ de France—April, 1910. No. 15704 G.

See also Engines, under STEAM ENGINEERING.

Watt Museum.

The Watt Relics at South Kensington F. A. Halsey. Illustrates and describes the more important of the Watt exhibits. 3000 w. Power—July 26, 1910. No. 15984.

The Watt Relics at South Kensington. F. A. Halsey. Illustrates and describes models, showing the importance of Watt's work. 2800 w. Am Mach—Vol. 33. No. 28. No. 15586.

TRANSPORTING AND CONVEYING.

Aerial Tramways.

Electric Aerial Tramways in Foundries (Elektrische Hängebahnen in Giessereien). Illustrates and describes a number of installations on the Bleichert system. Serial. 1st part. 2500 w. Giesserei-Zeit—June 15, 1910. No. 15783 D.

Cranes.

Travelling and Slewing Tower Transporter. Illustrations and description of a transporter for Victoria Docks, operated electrically. 800 w. Engr, Lond—July 1, 1910. No. 15566 A.

150-Ton Hammer-Head Crane. Plate, illustrations, and description of an electrically operated hammer-head crane for the Mitou Bishi Dockyard, Nagasaki, Japan. 2000 w. Engng—June 24, 1910. No. 15538 A.

See also Floating Cranes, under MARINE AND NAVAL ENGINEERING.

Elevators.

The Electric Elevator. William Baxter, Jr. Illustrated description of the elektron system with mechanical control. 1500 w. Power—July 5, 1910. No. 15325.

Electric Lifts on the Olympic and Titanic. Brief description of elevators for passengers, stores, and pantry service. 700 w. Engr, Lond—June 24, 1910. No. 15551 A.

A Novel Mountain Elevator. L. Ramakers. Illustrated description of an elevator recently put in service in Switzerland. 1000 w. Sci Am—July 23, 1910. No. 15809.

The Safety of Industrial Elevators (Gli Elevatori industriali Considerati nei Riguardi della Sicurezza del loro Eser-

cizio). L. Pontiggia. Discusses the regulations governing the installation and operation of passenger and freight elevators in various countries. Serial. 1st part. 2500 w. Industria—June 19, 1910. No. 15756 D.

Freight Handling.

Mechanical Transference of Water-Borne Freight. H. M'L. Harding. Describes the methods now employed at steamship terminals, showing the requirements of the service, discussing the value of mechanical conveyors for the handling of freight, and especially the economy of the electric hoist. 4500 w. Ry Age Gaz—July 8, 1910. No. 15468.

Lifting Magnets.

Electric Lifting Magnets in the Steel Plant. Illustrated article on the important uses of this conveying device. 1500 w. Elec Wld—July 7, 1910. No. 15485.

Ore Handling.

A 15-Ton Hulett Ore Unloader. Walter G. Stephan. Illustrated description of a new machine with 50 per cent. increase in bucket load and with receiving hopper, larry car, and mechanism for weighing the ore. 1800 w. Ir Age—July 21, 1910. No. 15800.

MISCELLANY.

Aeronautics.

Alphonse Pénaud, the Father of Modern Aviation (Alphonse Pénaud, der Vater der modernen Aviatik). Josef Popper. A review of the development of the fundamental principles of aeronautics. Serial. 1st part. 2000 w. Motorwagen—June 20, 1910. No. 15920 D.

Aerial Navigation (Sulla Navigazione aerea). Angelo Battelli. A discussion of its present development and possible future. 6000 w. Monit Tech—June 20, 1910. No. 15751 D.

Aeroplanes and Dirigibles in Naval Warfare (Velivoli e Dirigibili nella Guerra navale). Claudio Piumatti. A discussion of their offensive and defensive possibilities. 2000 w. Riv Marit—June, 1910. No. 15746 E + F.

By Air Across the Atlantic Ocean. Dr. Eugen Alt. Brief account of a projected aerial voyage from Europe to America. 1800 w. Sci Am Sup—July 2, 1910. No. 15405.

The Principle of the Helicopter. Herbert Chatley. Reports results of investigation of theoretical points in connection with the design and construction of this type of machine. 1000 w. Engr, Lond—July 1, 1910. No. 15558 A.

Wooden Construction for the Framework of Airships (Holzträger für Gerippe von Luftschiffen). Herr Lukomski. Discusses the design of wood frameworks. Ills. 1000 w. Zeitschr d Ver Deutscher Ing—June 18, 1910. No. 15953 D.

Analytical Calculation of Pressure and Pressure Distribution on Planes (Analytische Berechnung der Druckkraft und Druckverteilung an luftbeströmten Flächen). Erich Schneckenberg. Mathematical discussion of this element of aeroplane design. Ills. 2000 w. Elektrotech Rundschau—June 2, 1910. No. 15939 D.

The Theory, Calculation, and Construction of Aerial Propellers (Sur la Théorie, le Calcul et la Construction des Hélices aériennes). Ernest Comhaire. A brief review of aerial propeller design and construction. 2000 w. All Indus—June, 1910. No. 15728 D.

Testing Aerial Propellers. Illustrated description of a special apparatus at the works of the Vickers Co. for making practical tests of such propellers, with an outline of testing methods. 700 w. Engng—July 8, 1910. No. 15670 A.

Tests on Air Propellers (Versuche mit Hubschrauben). G. Klingenberg. Describes methods and gives results and conclusions. Ills. 6000 w. Zeitschr d Ver Deutscher Ing—June 18, 1910. No. 15951 D.

Aeroplane Constructional Details. Warren H. Miller. Discusses materials used and describes some constructional details. Ills. 3500 w. Am Mach—Vol. 33. No. 29. No. 15696.

The Antoinette Aeroplane (L'Aéroplane Antoinette). Describes in detail the construction of the aeroplane and motor. Ills. 2500 w. Tech Mod—June, 1910. No. 15725 D.

The Manufacture of French Aeroplanes. Warren H. Miller. Reviews the mechanical and trade developments in this new industry in France. Ills. 2000 w. Engineering Magazine—August, 1910. No. 15998 B.

The Wreck of the "Deutschland." Carl Dienstbach. An account of the loss of the third airship of Count Zeppelin. 1200 w. Sci Am—July 9, 1910. No. 15414.

Contemporary Dirigible Balloons (Les Aérostats dirigeables contemporains). Paul Renard. A discussion of their design and a description of various types. Ills. Serial. 1st part. 4500 w. Tech Mod—June, 1910. No. 15724 D.

See also Aeronautic Motors, under COMBUSTION MOTORS.

Agricultural Implements.

The Royal Agricultural Society's Show. Illustrates and describes interesting exhibits in the implement section. 3300 w. Engr, Lond—June 24, 1910. Serial. 1st part. No. 15548 A.

Safety Devices.

Prevention of Industrial Accidents. Frederick R. Hutton. Analysis of industrial accidents showing the importance of safety devices. Editorial note. 1800 w. Am Mach—Vol. 33. No. 30. No. 16012.

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MINING AND METALLURGY.

COAL AND COKE.

Briquetting.

Binders for Coal Briquets. C. L. Hubbard. Summary of results and recommendations from a bulletin issued by the U. S. Geol. Survey relating to tests made at the St. Louis plant. 2500 w. Elec Rev, N Y—July 16, 1910. No. 15639.

Coal Breakers.

The Beaver Brook Breakers. Truman M. Dodson, Jr. Illustrates and describes the equipment and construction for preparing anthracite. 3500 w. Mines & Min—July, 1910. No. 15342 C.

Coal Cutting.

Advantages and disadvantages of the Electric and Compressed Air Drive for Coal-Cutting Machines. 3000 w. Ir & Coal Trds Rev—July 1, 1910. No. 15573 A.

Coke-Oven Gas.

See Open-Hearth Furnaces, under IRON AND STEEL.

Coke-Oven Lining.

See Blast-Furnace Lining, under IRON AND STEEL.

Coke Ovens.

The Coppée Regenerative By-Product Coke Oven (Etude sur le Four à Coke à Régénération de Chaleur et à Récupération des Sous-Produits, Système Evence Coppée). Pierre Gilard. Describes the construction and operation of the oven and by-product recovery plant. Ills. 3600 w. Bul Sci d l'Assn d Elèves—April, 1910. No. 15701 D.

Coke Waterer.

An Automatic Coke Waterer. William L. Affelder. Illustrates and describes apparatus for overcoming some difficulties of operating rectangular coke ovens. 2200 w. Mines & Min—July, 1910. No. 15345 C.

Coking By-Products.

A New Method for the Recovery of Ammonia from the Products of Coal Distillation (Ein neues Verfahren zur Gewinnung des Ammoniaks aus Kohlendestillationsgasen). J. Reintgen. Describes the Burkheiser process. Ills. 4500 w. Zeitschr d Ver Deutscher Ing—June 11, 1910. No. 15948 D.

Electric Power.

Electricity in Mining Operations. J. Glynn Williams. Discussion and suggestions concerning the application of electricity to mining plants. 4500 w. Ir & Coal Trds Rev—July 1, 1910. No. 15572 A.

Electricity in West Virginia Mines. R. Neil Williams. On the economic advantages of electric operation, with a review of the development at the bituminous mines of West Virginia. Ills. 3500 w. Eng & Min Jour—July 2, 1910. No. 15355.

Electricity Rules at the Eastwood Collieries. Instructions given to those in charge of electric plant on the surface and underground, and also of coal-cutting machines. 3000 w. Ir & Coal Trds Rev—July 1, 1910. No. 15571 A.

England.

Coal Mines Inspection—1909. Digest of the reports of H. M. Inspector of Mines. 63000 w. Col Guard (Sup)—July 15, 1910. No. 15899 A.

Mexico.

Coal Mining Industry of the Mexican Republic. Edwin Ludlow. A review of the three developed coal basins in the state of Coahuila giving analyses and report of commercial conditions. 2000 w. Min Wld—July 9, 1910. No. 15467.

Mine Equipment.

Coal-Mine Equipment. W. S. Meyers. Abstract of paper read at Bluefield meeting of the W. Va. Coal Min. Inst. Deals with the kind of power; the generation and transmission of electricity, etc. 3500 w. Mines & Min—July, 1910. No. 15347 C.

Mine Power.

I. Some Considerations Affecting the Installation of Power at Collieries. F. Onslow. II. Power Production at Collieries, with Special Reference to Gas Power and Electrical Centralization. R. Crawford and H. Moores. Abstracts of two papers before the Min. Inst. of Scotland. 2500 w. Elect'n, London—June 24, 1910. No. 15519 A.

Mining.

Vital Facts Pertaining to Coal Mining. Floyd W. Parsons. A condensed review of recent practice. 6000 w. Eng & Min Jour—July 16, 1910. No. 15624.

Systematic Exploitation in the Pittsburg Coal-Seam. F. Z. Schellenberg. Shows methods of rib-drawing and of working in the Pittsburg region. 2000 w. Bul Am Inst of Min Engrs—July, 1910. No. 15858 F.

Hydraulic Breaking in Bituminous-Coal Mining (Stossträuken und hydraulische Kohlensprengung in Steinkohlenflözen). Herr Trippe. Read at the Düsseldorf Congress. Describes a method of coal mining which prevents the formation of dust. Ills. 4000 w. Glückauf—June 25, 1910. No. 15797 D.

A Criticism of Stoping (Kritik des Schüttelrutschenbetriebes). F. Jüngst. A comparison of overhand stoping with long-wall and other mining methods. 8000 w. Glückauf—June 18, 1910. No. 15791 D.

Nova Scotia.

See Rhode Island, under COAL AND COKE.

We supply copies of these articles. See page 966.

Peat.

Geologic Bearing of the Peat Beds of Anticosti Island. W. H. Twenhofel. Gives facts bearing on the method of deposition of the coal and on the climate of past coal-forming times. 3000 w. Am Jour of Sci—July, 1910. No. 15286 D.

Rescue Appliances.

Comparative Tests with Breathing Appliances (Vergelichende Versuche mit Atmungsapparaten). Herr Grahn. Discusses pricipally the Tissot apparatus. Ills. 2000 w. Glückauf—June 11, 1910. No. 15790 D.

Rescue Stations.

Mine Rescue Stations in Illinois. R. Y. Williams. Describes the design and equipment and the character of the training given. 3000 w. Eng & Min Jour—July 23, 1910. No. 15877.

Rhode Island.

The Northern Appalachian, Rhode Island and Nova Scotia Coal Fields. Information from the report of the fuel committee of the Boston Chamber of Commerce. 2500 w. Ry Age Gaz—July 8, 1910. No. 15473.

Russia.

The Russian Coal Trade. Information concerning the competition with British coal in the Baltic, and new deposits in the Russian far east. 2000 w. Ir & Coal Trds Rev—July 15, 1910. No. 15997 A.

Washing.

Mechanical Preparation of Coal. H. H. Stock. Read before the Int. Ry. Fuel Assn. Discusses the means of improving the fuel and increasing its value. 4500 w. Ry & Engng Rev—July 2, 1910. No. 15291.

COPPER.

Arizona.

Copper Mining in Metcalf District, Arizona. Peter B. Scotland. Illustrated description of methods used in handling low-grade ore. 5000 w. Eng & Min Jour—July 16, 1910. No. 15622.

Mining at Miami, Arizona. R. L. Herrick. Illustrated description of mine developments. 7500 w. Mines & Min—July, 1910. No. 15349 C.

Converters.

Converting Copper Mattes. H. Schroder. Illustrates and describes details of interesting work. 1500 w. Aust Min Stand—June 1, 1910. Serial. 1st part. No. 15504 B.

Flue Dust.

Flue Dust and Fume in Smeltery Gases. Lewis T. Wright. Explains how flue dust deposition was controlled by velocity, fume by temperature. 1700 w. Eng & Min Jour—July 16, 1910. No. 15620.

Germany.

Lead and Copper Deposits in Lower Silesia (Die Blei- und Kupfererzlagerstätten Neiderschlesiens und der auf ihnen betriebene Bergbau). A. Fleck. Describes the ore deposits and the mining operations. Ills. Serial. 1st part. 2500 w. Glückauf—June 25, 1910. No. 15799 D.

Mexico.

Cananea Mining District of Sonora, Mexico. S. F. Emmons. Gives the principal scientific results of a survey made in 1907, describing especially the property of the Greene Cananea Copper Co. Map. 16000 w. Ec-Geol—June, 1910. No. 15842 D.

Cananea Consolidated Copper Co. in 1909. L. D. Ricketts. Abstract from the 1909 report of the Greene Consolidated Copper Co. 3500 w. Eng & Min Jour—July 9, 1910. No. 15462.

Nevada.

The Yerington Copper District. Jay A. Carpenter. Illustrated article reviewing the history of this district and describing the mines. 4000 w. Min & Sci Pr—July 2, 1910. No. 15431.

Slags.

Heats of Formation of Some Ferro-Calcic Silicates. H. O. Hofman and C. Y. Wen. Reports an investigation made to supply heat values as far as possible. Ills. 3500 w. Bul Am Inst of Min Engrs—July, 1910. No. 15861 F.

Smelter Fumes.

See Flue Dust, under COPPER.

Smelters.

Smelting Works of Tezeutlan Copper Company. A. van Zwaluwenburg. Illustrated description of a plant utilizing gravity in handling all material. 2800 w. Eng & Min Jour—July 23, 1910. No. 15875.

Smelting.

Cananea Furnace Practice. Courtenay De Kalb. Detailed discussion of the practice at the great smelter of the Cananea Consolidated Copper Co. Ills. 3000 w. Min & Sci Pr—July 2, 1910. No. 15432.

See also Roasting, under ORE DRESSING AND CONCENTRATION.

Spain.

The Pyritic Deposits of Huelva, Spain. A. Moncrieff Finlayson. Gives results of investigations into the pyritic masses of the important copper district of southern Spain and Portugal. 4000 w. Ec-Geol—June, 1910. Serial. 1st part. No. 15843 D.

GOLD AND SILVER.

Australia.

Catherine Reef United Mine, Bendigo (V.). Describes a massive quartz deposit; the greater part being low-grade ore. 2500 w. Aust Min Stand—June 1, 1910. No. 15505 B.

See also Gold Milling, under ORE DRESSING AND CONCENTRATION.

Cyaniding.

Continuous Pachuca Tank Agitation at the Esperanza Mill. M. H. Kuryla. Read before the Inst. Mexicano de Minas y Metalurgia. Describes the continuous system of agitation in treating the granu-

lar slime resulting from regrinding of the battery sands. 1000 w. Met & Chem Engng—July, 1910. No. 15430 C.

Silver Cyaniding at the San Rafael Mill, Pachuca. E. Girault. Describes the treatment and gives the per cent. of extraction and cost. Ills. 2000 w. Eng & Min Jour—July 9, 1910. No. 15461.

See also Crushing, under ORE DRESSING AND CONCENTRATION.

Dredging.

Less Known Gold Dredges in California. W. M. Knox. Brief descriptions of dredges working with good results in isolated districts. Ills. 1000 w. Min & Sci Pr—July 2, 1910. No. 15433.

Gold Dredging and Rock Crushing in California. George Bowers. Describes dredges and methods used successfully in the Folsom Division of the Natomas Consolidated. Ills. 2500 w. Eng Rec—July 16, 1910. No. 15628.

Georgia.

Gold Deposits of Georgia. E. K. Soper. Information concerning the deposits and their development. 2200 w. Min & Sci Pr—June 25, 1910. No. 15294.

Idaho.

Boise Basin, Idaho. W. A. Scott. Describes the locality and gives an account of placer mining in the past and present. 2000 w. Min & Sci Pr—July 16, 1910. No. 15825.

Nevada.

The Tonopah Extension Mine and Mill, Nevada. A. H. Martin. Illustrated description of the property. 1500 w. Min Wld—July 2, 1910. No. 15341.

Rawhide, Its Past, Present, and the Future. P. R. Whytock. Reviews the history of this mining district, describing the gold and silver ore deposits. Map. 2000 w. Min Wld—July 16, 1910. No. 15641.

Geology and Ore-Deposits of the Goldfield District, Nevada. F. L. Ransome. This present number gives map and description of the general geology of this district. 2500 w. Ec-Geol—June, 1910. Serial. 1st part. No. 15841 D.

Faulting in the Bullfrog District, Nevada. W. H. Emmons and G. H. Garrey. Abstract from Bull. 407, U. S. Geol. Surv. A descriptive study of this region. Ills. 2000 w. Min & Sci Pr—June 25, 1910. Serial. 1st part. No. 15296.

Rand.

Metallurgy on the Rand. Horace G. Nichols. Illustrations and report of conditions as observed on a recent trip to South Africa. 1000 w. Mining Mag—July, 1910. No. 15990 B.

South Dakota.

The Black Hills of South Dakota. Wililam H. Storms. An account of the discovery and matters related is given in the present number. Ills. Min & Sci Pr—July 23, 1910. Serial. 1st part. No. 16035.

Utah.

The Daly Judge Mine and Mill, Park City, Utah. Leroy A. Palmer. Illustrated detailed description. 3500 w. Min Wld—July 2, 1910. No. 15340.

IRON AND STEEL.

Bessemer Process.

The Present Status of the Basic Bessemer Process in Germany. Review and synopsis of a paper by W. Esser, read at the Int. Cong. at Dusseldorf, Germany. 3000 w. Ir Age—July 14, 1910. No.15575.

Introduction of the Thomas Basic Steel Process in the United States. George W. Maynard. Detailed review of the history of the process. 4000 w. Bul Am Inst of Min Engrs—July, 1910. No. 15862 F.

Blast-Furnace Charging.

The Mechanical Charging of Blast Furnaces. Edgar J. W. Richards and Thomas Lewis. Abstract of a paper read before the Cleveland Inst. of Engrs., England. Discuesses the requirements and reviews the chargers in use, describing a new design believed to be an improvement. Ills. 5000 w. Can Min Jour—July 15, 1910. No. 15635.

Blast-Furnace Gas.

A Quantitative Investigation of the Source of Hydrogen in Blast Furnace Gas. R. J. Wysor and W. D. Brown. Gives results of investigations, with details of the test. 2500 w. Met & Chem Engng—July, 1910. No. 15423 C.

The Cost of Electric Power from Furnace Gases (Die Erzeugungskosten der elektrischen Kraft unter Ausnutzung des Hochofengases). Rudolf Pokorny. Discusses the cost of power in both gas and steam plants. Ills. 4000 w. Stahl u Eisen—June 8, 1910. No. 15767 D.

See also Open-Hearth Furnaces, under IRON AND STEEL.

Blast-Furnace Lining.

Changes in the Composition of Refractory Materials (Ueber die Wandlung in der Zusammensetzung feuerfester Steine). Dr. Blasberg. Read at the Düsseldorf Congress. Gives a number of analyses showing the alteration of coke-oven and blast-furnace linings. 3000 w. Stahl u Eisen—June 22, 1910. No. 15776 D.

Blast-Furnace Operation.

Grüner's Ideal Working of a Blast Furnace. Joseph W. Richards. Read before the Int. Cong. of Min. & Met. Aims to show that this ideal is not true for some blast furnaces under usual conditions, and not true of many blast furnaces under certain unusual conditions. 1200 w. Met & Chem Engng—July, 1910. No. 15425 C.

The Fuel Economy of the Blast Furnace (Der Wärmewert des Brennstoffes im Schachtofen und insbesonders im Eisenhochofen). Josef v. Ehrenwerth. A continuation of the author's papers begun in Sept., 1909, dealing specially with the iron blast furnace. Serial. 1st part. 2800

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w. Oest Zeitschr f Berg u Hüttenwesen—June 4, 1910. No. 15785 D.

Blast Furnaces.

The Reconstructed Earlston Furnace. Illustrates and describes interesting details of a reconstructed furnace at Everett, Pa. 1200 w. Ir Trd Rev—July 7, 1910. No. 15418.

New Plant and Blast Furnace of the Northwestern Iron Co., Mayville, Wis. Brief sketch of the location and history, with illustrated description of features of the mines and new furnace. 2500 w. Ir Trd Rev—July 28, 1910. No. 16032.

Blast-Furnace Slags.

A Metallographic Study of Iron and Steel Slags (Etude métallographique des Scories du Fer et de l'Acier). M. Matweieff. Illustrated with microphotographs. 2700 w. Rev de Métal—June, 1910. No. 15712 E + F.

The Value of Microscopic Study in the Examination of Blast-Furnace Slags (Ueber den Wert mikroskopischer Untersuchungen für die Beurteilung von Hochofenschlacke). H. Passow. Read at the Düsseldorf Congress. Shows what a microscopic investigation will reveal. Ills. 2500 w. Stahl u Eisen—June 15, 1910. No. 15770 D.

Blowers.

The Application of Turbo-Blowers to Blast Furnaces (Note sur l'Application des Souffleries rotatives aux Hauts Fourneaux). A. Gouvy. Reviews their advantages and shows their economy. Ills. 3000 w. Mem Soc Ing Civ de France—April, 1910. No. 15705 G.

The Driving of Steel-Works Blowers (Ueber die Wirtschaftlichkeit der verschiedenen Antriebsarten von Stahlwerks- Gebläsemaschinen). Herr Mauritz. Read at the Düsseldorf Congress. Discusses the economy of steam, gas, and electric operation. Ills. 4200 w. Stahl u Eisen—June 22, 1910. No. 15774 D.

Electrometallurgy.

The Development of Electric Smelting of Iron and Steel (Die Entwicklung der elektrischen Eisen- und Stahlerzeugung). Dr. Juliusburger. A review of electric-furnace types and oneration. Ills. 3500 w. Elek Kraft u Bahnen—June 4, 1910. No. 15937 D.

Present Status of Electric Steel Production (Ueber den heutigen Stand der Elektrostahlverfahren). B. Neumann. Read at the Düsseldorf Congress. A review of the types of furnaces in use and the results obtained. Ills. 6000 w. Stahl u Eisen—June 22, 1910. No. 15778 D.

The Theoretical and Practical Importance of the Electric Shaft Furnace (Ueber die theoretische und praktische Bedeutung des elektrischen Hochofens). Carl Brisker. Read at the Düsseldorf Congress. Reviews results at Domnarfvet and discusses the possibilities of the shaft furnace. 10000 w. Stahl u Eisen—June 22, 1910. No. 15775 D.

Laboratories.

The Organization of Some German and Belgian Laboratories (Notes sur l'Organisation de quelques Laboratories allemands et belges). G. Arnou. Describes laboratory equipment and practice in some German and Belgian steel works. Ills. 6500 w. Rev de Métal—June, 1910. No. 15709 E + F.

Native Iron.

Native Iron (Ueber tellurisches Eisen). E. Priwoznik. Discusses the occurrence of pure iron in nature, reviewing the discoveries. 2500 w. Oest Zeitschr f Berg u Hüttenwesen—June 11, 1910. No. 15786 D.

Open-Hearth Furnaces.

Recent Improvements in the Construction of the Open-Hearth Furnace. O. Friedrich. Read before the International Cong. at Düsseldorf. Explains some of the problems, and illustrates and describes improvements made. 2500 w. Ir & Coal Trds Rev—July 8, 1910. Serial. 1st part. No. 15686 A.

Recent Improvements in the Construction of Martin Furnaces (Neuere konstruktive Verbesserungen an Martinöfen). O. Friedrich. Read at the Düsseldorf Congress. Detailed description of new and important features. Ills. 5500 w. Stahl u Eisen—June 15, 1910. No. 15769 D.

The Application of Various Kinds of Gas to the Operation of Open-Hearth Furnaces and Their Influence on the Quality of the Product (Ueber die Verwendung der verschiedenen Gasarten zum Betrieb von Herdöfen und ihren Einfluss auf die Qualität der Erzeugnisse). Herr Terpitz. Read at the Düsseldorf Congress. Discusses the use of blast-furnace and coke-oven gases. 2500 w. Stahl u Eisen—June 15, 1910. No. 15773 D.

Open-Hearth Process.

German Open Hearth Processes. R. Genzmer. Synopsis of a paper read at the Dusseldorf Congress on "Pig Iron-Ore Processes in Germany." 2500 w. Ir Age—July 28, 1910. No. 16033.

Quebec.

I. Iron Ore Deposits of the Bristol Mine, Pontiac County, Que. E. Lindeman. II. Magnetic Concentration of Ores. George C. Mackenzie. The first article gives a report of a magnetometric survey, etc. Ills. Maps. 3300 w. Can Dept of Mines—Bul. No. 2. No. 16005 N.

Rolling Mills.

Early Days in the Rolling Mills. The address of John Fritz at the centennial celebration at Coatsville, Pa., telling of the opposition to his three-high mill. Ills. 3000 w. Ir Trd Rev—July 14, 1910. No. 15608.

A Modern Universal Rolling Mill

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(Modernes Universal-Walzwerk). Details of a rolling mill embodying several new features. Ills. 1800 w. Stahl u Eisen—June 8, 1910. No. 15768 D.

A Decade's Progress in the Construction of Roll Trains (Konstruktive Neuerungen an Walzenstrassen im letzten Jahrzehnt. H. Ortmann. Read at the Düsseldorf Congress. A detailed illustrated review of recent improvements. 8500 w. Stahl u Eisen—June 15, 1910. No. 15772 D.

Segregation.

Titanium and Segregation. G. B. Waterhouse. Read before the Am. Soc. for Test. Mat. Discusses the influence of titanium on segregation in Bessemer rail steel. Ills. 1200 w. Ir Age—July 7, 1910. No. 15305.

Steel Works.

One Hundred and Thirty Years of Iron and Steel Making. Illustrated review of the development of the Lukins Iron & Steel Co., Coatesville, Pa. 3500 w. Ir Trd Rev—June 30, 1910. No. 15293.

Sweden.

Iron Mining in Sweden (Der Abbau der Eisenerze in Schweden). Herr Bentz. Describes mining methods in various localities. Ills. 5500 w. Glückauf—June 4, 1910. No. 15789 D.

LEAD AND ZINC.

Germany.

See same title, under COPPER.

Kentucky.

The Fluorspar, Lead and Zinc Deposits of Western Kentucky. F. Julius Fohs. Describes these deposits of economic and scientific interest. 3000 w. Ec-Geol—June, 1910. No. 15845 D.

Lead Smelting.

Unhealthful Practices in the Metallurgy of Lead. Edgar L. Collins. Abstract of a "Special Report on Dangerous or Injurious Processes in the Smelting of Materials Containing Lead," made to the British Parliament. 1500 w. Eng & Min Jour—July 16, 1910. No. 15621.

Missouri.

Lead Mining in the Joplin District. Lucius L. Wittich. Describes early operations in the production of lead in connection with zinc mining. Ills. 3000 w. Mines & Min—July, 1910. No. 15348 C.

MINOR MINERALS.

Cement.

Aluminates; Their Properties and Possibilities in Cement Manufacture. Henry S. Spackman. Read before the Am. Soc. for Test. Mat. Aims to show the value of combinations of aluminates with a base as an addition to cements and mortars, and their power of increasing the strength and hydraulic properties. 2500 w. Eng Rec—July 9, 1910. No. 15452.

See also same title, under CIVIL ENGINEERING, MATERIALS OF CONSTRUCTION.

Fluorspar.

See Kentucky, under LEAD AND ZINC.

Natural Gas.

The Beginning of the Use of Natural Gas for Fuel. John L. Cowan. Refers to ancient uses, and gives an account of its early commercial supplies. 2200 w. Min & Sci Pr—July 9, 1910. No. 15601.

Natural Gas and Its Production. Harold A. Danne. Information concerning these deposits, their use, wasteful methods, theories relating to their generation, and related subjects. 2000 w. Met & Chem Engng—July, 1910. No. 15428 C.

Natural Gas Field Near Fayette, Ala. Dr. David T. Day. Describes the supply found and the development work, giving a log of well No. 1. 1200 w. Mfrs' Rec—July 7, 1910. No. 15393.

Future of Natural Gas in Oklahoma. Charles N. Gould. Read before the Nat. Gas Assn. of America. Discusses the location, quantity, and utilization of this product in Oklahoma. Maps. 5500 w. Pro Age—July 15, 1910. No. 15578.

The Conservation of Natural Gas. J. C. McDowell. Read before the Nat. Gas Assn. of America. Brief review of the history and utilization of this product in the regions discovered and developed, discussing the waste. 3000 w. Pro Age—July 15, 1910. No. 15577.

Nickel.

The Alexo Nickel Deposit. A. P. Coleman. Brief description of this interesting deposit in Northern Ontario. Ills. 700 w. Ec-Geol—June, 1910. No. 15844 D.

Nitrates.

History and Review of the Niter Industry of Chile. Mark R. Lamb. Information from a new book by Semper and Nichols, Santiago, Chile, giving an exhaustive review of the history of this industry. Ills. 5500 w. Eng & Min Jour—July 2, 1910. No. 15354.

Oil.

The Oilfields of Mexico. H. S. Denny. Map and report of this oil region and its development. 3000 w. Mining Mag—July, 1910. No. 15989 B.

The Economics of the Petroleum Industry (Der Wirtschaftsbetrieb des Erdöles). F. W. Möller. A review of the petroleum industry of the world. Ills. Serial. 1st part. 2000 w. Tech u Wirt—June, 1910. No. 15963 D.

Tin.

The Tin-Mining Industry of Cornwall. A review of this industry in England and the methods of mining under the sea. 2500 w. Sci Am Sup—July 30, 1910. No. 16031.

MINING.

Accidents.

Mining Accidents. Gives statistics showing a recent increase in mine accidents, and discusses the causes. 1200 w. Engr, Lond—July 1, 1910. No. 15556 A.

We supply copies of these articles. See page 966.

Boring.

A Remarkable Drill Core. An illustration of the practicability of drilling holes 29 inches in diameter and saving core. 1500 w. Mines & Min—July, 1910. No. 15346 C.

Electric Hoisting.

Progress in the Construction of Electric Hoists to 1910 (Fortschritte im Bau elektrischer Fördermaschinen bis 1910). Josef Blazet. Discusses the cost of electric hoisting plants, improvements in efficiency, etc. Ills. Serial. 1st part. 3600 w. Oest Zeitschr f Berg u Hüttenwesen—June 18, 1910. No. 15787 D.

Haulage.

Electric Rope Haulage. W. O. Vickery. Describes the system in use at Midway Mine, Colorado, which is a combination of electric hoists and tail rope haulage. 2800 w. Mines & Min—July, 1910. No. 15343 C.

Protection of Trolley Wires in Electric Mine Haulage (Schutzmassnahmen gegen Berühren der Fahrdrähte elektrischer Grubenbahnen). Herr Spackeler. Describes a number of devices to prevent contact with the wires. Ills. 3500 w. Glückauf—June 25, 1910. No. 15798 D.

Hoisting Ropes.

Mechanical Investigation of the Influence of Galvanizing on Hoisting Ropes (Mechanische Untersuchungen über den Einfluss der Verzinkung auf Förderseildrähte). Herr Speer. Describes the tests and gives the results in detail. Serial. 1st part. 5600 w. Glückauf—June 4, 1910. No. 15788 D.

Metallographic Investigation of the Influence of Galvanizing on Winding Ropes (Metallographische Untersuchungen über den Einfluss der Verzinkung auf Förderseildrähte). H. Winter. Read at the Düsseldorf Congress. An exhaustive discussion of the effect of protective treatment. Ills. 8500 w. Glückauf—June 18, 1910. No. 15793 D.

Hydraulic Mining.

The Long-Tom and Hydraulic Mining in California. R. H. Campbell. Describes this device, used in the early mining days, and gives a brief account of the hydraulic mining period. Ills. 1800 w. Min & Sci Pr—June 25, 1910. No. 15297.

Law.

Mining Law in the German Dependencies (Das Bergrecht in den deutschen Schutzgebieten). W. Westhoff. A review of the mining regulations of the various German colonies. 1300 w. Glückauf—June 18, 1910. No. 15796 D.

Methods.

The Mitchell Slicing System at Bisbee, Arizona. Morris J. Elsing. Describes a modification of the square set method, which reduces timber cost and saves labor. 1500 w. Eng & Min Jour—July 23, 1910. No. 15876.

Placer Mining.

Mobility in Placer Mining. John Power Hutchins. Brief discussion of the importance of factor of mobility in all placer-mining operations. Ills. 1400 w. Mining Mag—July, 1910. No. 15991 B.

Power Plants.

Surface Equipment at Clonan Shaft, Mineville, N. Y. Guy C. Stoltz. Illustrated description of a modern steam operated power plant for an iron mine producing 2000 tons per day. 1500 w. Eng & Min Jour—July 23, 1910. No. 15874.

Power Plants of the Cobalt District, Ontario. Alex. Gray. Illustrated description of the power plants designed to supply the Cobalt mines with compressed air. 2000 w. Min Wld—July 23, 1910. No. 15872.

See Condensers, under MECHANICAL ENGINEERING, STEAM ENGINEERING.

Pumping.

Deep Pumping on the Comstock. A history of the drainage difficulties and methods adopted to overcome them. Ills. 3000 w. Mines & Min—July, 1910. No. 15350 C.

Shafts.

The Tubbing and Re-Tubbing of Shafts. G. R. Thompson. Read before the Nat. Assn. of Col. Mgrs. The meaning of the term as first used and as used by the writer is explained, stresses discussed, forms, strength, applications, etc. Ills. 6000 w. Ir & Coal Trds Rev—July 1, 1910. No. 15569 A.

Shaft Sinking.

The Sinking and Equipping of Penallta Colliery. George G. Hann. From the *Trans. of the S. Wales Inst. of Engrs.* The surface arrangements are illustrated and described in the present number. 1200 w. Col Guard—July 15, 1910. Serial. 1st part. No. 15898 A.

Rapid Shaft Sinking in Butte. C. J. Stone. Notes on methods used in sinking the shaft of the Butte-Alex Scott Copper Co. below the 1400-ft. level. 1000 w. Eng & Min Jour—July 16, 1910. No. 15619.

Stoping.

Stoping at Homestake Mine of South Dakota. John Tyssowski. Describes the methods employed and the cost of excessive shoveling. Ills. 2000 w. Eng & Min Jour—July 9, 1910. No. 15463.

Surveying.

Analytical Geometry in Mine Survey Problems. J. J. Bristol. Gives problems solved by an application of analytical geometry. 2500 w. Min Wld—July 9, 1910. No. 15465.

Timbering.

The Employment of Reinforced-Concrete in Mining (Die Verwendung von Eisenbeton beim Grubenausbau). Herr Viebig. Read at the Düsseldorf Congress. Discusses a number of applications in which this material is replacing timber.

We supply copies of these articles. See page 966.

Ills. 12000 w. Glückauf—June 18, 1910. No. 15792 D.

Ventilation.

Mine Resistance. Thomas W. Fitch. Reviews the laws governing the flow of fluids and explains method of measuring resistance to the flow of air. 4000 w. Mines & Min—July, 1910. No. 15344 C.

Test of a Fan Driven by a Three-Phase Motor (Untersuchung eines Drehstrommotor-Ventilatorantriebes mit maschineller Umdrehungsregelung). Describes the plant and the test, and gives results. Ills. 2000 w. Glückauf—June 18, 1910. No. 15795 D.

ORE DRESSING AND CONCENTRATION.

Briquetting.

Iron-Ore Briquetting and Agglomerating in Germany (Der gegenwärtige Stand der Eisenerz-Brikettierung und -Agglomerierung in Deutschland). G. Franke. Read at the Düsseldorf Congress. Describes various processes in use. 2500 w. Stahl u Eisen—June 22, 1910. No. 15777 D.

Crushing.

Crushing Machines for Cyanide Plants. Mark R. Lamb. Remarks on the changes in the cyanide process, reviewing the various machines for crushing, grinding, etc. 1400 w. Bul Am Inst of Min Engrs—July, 1910. No. 15860 F.

Milling and Crushing Exhibits at the Brussels Exhibition (Müllerei und Hartzerkleinerung auf der Weltausstellung in Brüssel). Carl Naske. A preliminary report. Serial. 1st part. 1000 w. Zeitschr d Ver Deutscher Ing—June 18, 1910. No. 15950 D.

Electrostatic Separation.

Electrostatic Separation of Minerals in Ores. Henry A. Wentworth. Describes the Huff electrostatic separators and the principles on which they are based, illustrating plants where they are successfully used. 2500 w. Eng & Min Jour—July 2, 1910. No. 15353.

Filters.

The "Turn-Over" Mechanically-Cleaned Filter. Illustrated description of a filter in the form of a cylindrical barrel, lying with its axis horizontal and so arranged that it may be rotated. 1800 w. Engng—June 10, 1910. No. 15498 A.

Gold Milling.

Progress in Ore Treatment at Kalgoorlie. M. W. von Bernewitz. Abstracted from "The Gold Mines of Western Australia." Reviews the rapid progress made since 1893. 3000 w. Min & Sci Pr—June 25, 1910. No. 15295.

Jigs.

Methods of Modern Ore Concentration. Charles C. Christensen. Describes two plants, one employing the Hancock type of jig, and one the Hartz type of jig. Gives flow sheets. 1200 w. Min Wld—July 9, 1910. No. 15466.

Magnetic Concentration.

See Quebec, under IRON AND STEEL.

Roasting.

Chloridizing Roasting of Cuprous Pyrites Cinders. Sten Lilja. Illlustrated detailed description of the Henderson process for the extraction of copper from pyrite cinders. 5000 w. Met & Chem Engng—July, 1910. No. 15424 C.

Sampling.

Accuracy of Mechanical and Riffle Ore Samples. Louis D. Huntoon. Discusses the requirements of mechanical ore samplers, the cause of inaccurate results with riffles, etc. 2500 w. Eng & Min Jour—July 9, 1910. No. 15460.

Slimes Treatment.

The Elements of Slime Concentration. Walter McDermott. Read before the Inst. of Min. & Met. A statement of certain elements, established by practice, with conclusions indicating the most promising direction for improvements. 7200 w. Met & Chem Engng—July, 1910. No. 15427 C.

Stamp Mills.

Power Required in Stamp Milling Operations. A. W. Warwick. A study of the power consumed by a stamp mill, how it is utilized and how to calculate the power required by any stamp. 3000 w. Min Wld—July 23, 1910. No. 15873.

MISCELLANY.

Australasia.

The Australasian Institute of Mining Engineers. A report of the Congress at Mount Morgan, Central Queensland, with the presidential address, papers read, etc. Ills. 13000 w. Aust Min Stand—June 8, 1910. Serial. 1st part. No. 15688 B.

Dusseldorf Congress.

The International Congress of Mining, Metallurgy and Practical Geology at Dusseldorf Germany. Interesting account of this congress and the entertainment furnished. 3000 w. Eng News—July 14, 1910. No. 15594.

The International Congress of Mining, Metallurgy and Applied Geology. Charles Kirchhoff. Gives abstracts of important papers at Dusseldorf on recent practice in iron and steel and related industries. 12000 w. Ir Age—July 14, 1910. No. 15574.

International Congress of Mining and Metallurgy at Dusseldorf. First of a series of articles on the work of this congress. The present number reviews the work of the Mining Section. 2500 w. Engr, Lond—July 1, 1910. Serial. 1st part. No. 15563 A.

Glacial Lakes.

Glacial Lakes and Their Relation to Mining. Arthur Lakes. Drawings and descriptions of these amphitheaters, formed by erosion, where veins are often exposed. 1700 w. Min Wld—July 16, 1910. No. 15642.

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Louisiana.

Conserving Mineral Resources of Louisiana. C. Willard Hayes. Introductory remarks, with a discussion of the various economic minerals of the state and the conservation policy that should be adopted. 4400 w. Mfrs' Rec—June 30, 1910. No. 15288.

Ore Deposits.

The Ultimate Source of Ores. Charles R. Keyes. Considers the four phases of primary ore-genesis, discussing each in detail. 6800 w. Bul Am Inst of Min Engrs—July, 1910. No. 15859 F.

Economies of Secondary Enrichment. A. M. Finlayson. A study of the chemical and physical processes in the enrichment of typical ores. 3500 w. Min & Sci Pr—July 16, 1910. Serial. 1st part. No. 15824.

Refractory Materials.

Measurement of the Thermal Conductivity of Fireclay. Describes a method developed by Dr. J. K. Clement and W. L. Egy, and described in Bul. 36 of the Engng Ex. Station of the Univ. of Illinois., illustrating its application by example. Ills. 1800 w. Met & Chem Engng—July, 1910. No. 15429 C.

RAILWAY ENGINEERING.

CONDUCTING TRANSPORTATION.

Signaling.

The Block Signal Question. James Brandt Latimer. Explains the nature of the block system, and the manual and automatic blocking, discussing features and efficiency of the two systems. 5500 w. Eng News—June 30, 1910. No. 15396.

British Methods of Operating Single Tracks. Explains the use of the train staff, and the block system, and the electrically controlled token system. Ills. 2000 w. Can Engr—July 21, 1910. No. 15864.

Train Service.

The Summer Train Service. A review of the summer service on British railways. 1600 w. Engr, Lond—July 1, 1910. No. 15562 A.

MOTIVE POWER AND EQUIPMENT.

Air Brakes.

Undesired Quick Action. Shows the causes and conditions likely to produce undesired quick action. Also describes an invention for preventing it. 2800 w. Ry & Loc Engng—July, 1910. No. 15330 C.

Electrification.

The Electrification of Railways. George Westinghouse. Calls attention to the necessity for the early selection of a system for universal use. Ills. 10500 w. Jour Am Soc of Mech Engrs—July, 1910. No. 15834 F.

Economies of Railway Electrification. William Bancroft Potter. A study of the problem, discussing conditions determining railway equipment, interurban railways, etc. Ills. 3500 w. Jour Am Soc of Mech Engrs—July, 1910. No. 15835 F.

The Electrification of the Lapland Railway. Gives details of the plans with a map of the district affected. 2500 w. Engng—July 1, 1910. No. 15545 A.

Freight Cars.

Steel in Freight Car Construction. C. A. Seley. An illustrated discussion of car design and the composite construction of freight cars. 3000 w. Ry Age Gaz—July 8, 1910. No. 15472.

New Tank Car. Illustrated description of a design built by the Chicago Steel Car Co., which lessens the height of the center of gravity of the loaded car 18 inches. 600 w. Ry Age Gaz—July 15, 1910. No. 15611.

Locomotive Boilers.

Report No. 6, for All Countries Except Russia, America, Austria, Hungary, Roumania, Bulgaria, Servia, Turkey, France, Belgium, Italy, Spain, Portugal and Great Britain, on the Question of Improvements in Locomotive Boilers. Karl Steinbiss. Ills. 39000 w. Bul Int Ry Cong—June, 1910. No. 15996 G.

The New Water-Tube Boiler under Test in the High-Speed Locomotive 2.741 of the Northern of France (La nouvelle Chaudière à Foyer à Tubes d'Eau à l'Essai sur la Locomotive à grande Vitesse. 2.741 de la Compagnie du Nord). J. Kœchlin. Illustrated description. 3000 w. Rev. Gen d Chemins de Fer—June, 1910. No. 15716 G.

Locomotive Construction.

Report No. 6, for Great Britain, on the Question of the Use of Special Steels. Wilson Worsdell. Considers the use of special steels of high resistance in the making of the various parts of locomotives and rolling stock. 3600 w. Bul Int Ry Cong—June, 1910. No. 15994 G.

Locomotive Frames.

Locomotive Frame Construction. H. T. Bentley. Read before the Am. Ry. Mas. Mech. Assn. Introductory to discussion of what can be done to increase the life of engines between general repairs. 2000 w. Am Engr & R R Jour—July, 1910. No. 15480 C.

Locomotive Front Ends.

Front End Tests. Gives results of a series of tests on the locomotive testing plant at Altoona to determine the best arrangement of front ends for Pennsylvania At-

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lantic type locomotives, classes E 2a and E 3a. Ills. 3000 w. Am Engr & R R Jour—July, 1910. No. 15474 C.

Tests of Self-Cleaning Front Ends, Pennsylvania Railroad. A detailed report of tests made on a E 2a locomotive and E 3a. 2000 w. Ry Age Gaz—July 15, 1910. No. 15614.

Locomotive Fuels.

Oil Fuel for Locomotives, with Special Reference to the Coal-Tar Oil Tests of the Prussian State Railways (Ueber Oelfeuerung für Lokomotiven, mit besonderer Berücksichtigung der Versuche mit Teerölzusatzfeuerung bei den preussischen Staatsbahnen. L. Sussmann. Discusses the utilization of gas-works by-products. Ills. Serial. 1st part. 3000 w. Gläsers Ann—June 1, 1910. No. 15922 D.

Locomotive Operation.

Education as an Essential of Fuel Economy. W. C. Hayes. Read before the Am. Ry. Mas. Mech. Assn. Deals with the instruction and educational development of enginemen. 2200 w. Am Engr & R R Jour—July, 1910. No. 15478 C.

Locomotive Repairs.

Locomotive Running Repairs. Remarks on the improvements in locomotive repair shops, and on the readjustment of valve gear. Ills. 2500 w. Ry & Loc Engng—July, 1910. No. 15329 C.

Locomotives.

A Tabular Comparison of Notable Examples of Recent Locomotives. Gives tables arranged with respect to total weights, and arranged with respect to classes and weights. 3000 w. Am Engr & R R Jour—July, 1910. No. 15477 C.

Crampton Locomotives. Alfred R. Bennett. An article, supplementary to Herr v. Gaiser's work on these locomotives, dealing with the rebuilt and the 4-wheeled classes. Ills. 1500 w. Engr, Lond—July 1, 1910. No. 15561 A.

Locomotives at the Brussels Exhibition. Illustrates and describes extra powerful grade and express locomotives for heavy trains on the Belgian State Rys., and for the Bavarian State Rys. Also editorial. 3500 w. Engr, Lond—June 24, 1910. Serial. 1st part. No. 15547 A.

Mallet Articulated Locomotive 2-8-8-2 Type. New locomotives for the Norfolk & Western Ry. are illustrated and described. 800 w. Am Engr & R R Jour—July, 1910. No. 15476 C.

Pacific and Consolidation Type Locomotives. Illustrated detailed description of recent locomotives of these types for the Chicago & Northwestern railway. 800 w. Am Engr & R R Jour—July, 1910. No. 15475 C.

Mallet Compound Locomotive for the Natal Government Railways. Illustrated detailed description of engine doing satisfactory work on heavy grades. Plate. 1000 w. Engng—July 8, 1910. No. 15672 A.

Consolidation Type Locomotive for the South Manchuria Railway. Illustrated description of a powerful engine, one of twelve recently completed. 700 w. Engr, Lond—July 15, 1910. No. 15978 A.

Locomotive Superheating.

Locomotive Superheaters. Data and illustrated descriptions of successful types. 3000 w. Mach (Ry. Ed.)—July, 1910. No. 15383 C.

Locomotive Valve Gears.

The Kinematics of Two-Eccentric Link Motions (Ein neues Verfahren zur Ausmittlung der Zweiexzenter-Kulissensteuerungen). L. Baudiss. Gives a new method for the solution of Stephenson, Allan and Gooch link-motion problems. Ills. 3000 w. Zeitschr d Oest Ing u Arch Ver—June 3, 1910. No. 15925 D.

Passenger Cars.

See also Heat Insulation, under MECHANICAL ENGINEERING, MATERIALS OF CONSTRUCTION.

Shops.

New Shops of the Central of Georgia Ry., Macon, Ga. Illustrated detailed description of shops located on uneven ground near the center of a city, and their equipment. 3500 w. Ry & Engng Rev—July 16, 1910. No. 15643.

Locomotive and Car Shops of the National Trans-Continental, Winnipeg, Canada. Plan and description of shops and equipment. 4000 w. Ry Age Gaz—July 22, 1910. No. 15831.

The Eastleigh Locomotive Works of the London and South-Western Railway Company. An illustrated account of the new shops and some of the principal tools and machines acquired. Plate. 2500 w. Engr, Lond—July 15, 1910. Serial. 1st part. No. 15976 A.

Locomotive Building at Altoona. Ralph E. Flanders. Illustrated detailed description of methods of driving-box manufacture used at the Juniata shops. 3000 w. Mach (Ry. Ed.)—July, 1910. No. 15382 C.

Train Resistance.

Feight Train Resistance; Its Relation to Average Car Weight. Edward C. Schmidt. Read before Am. Ry. Mas. Mech. Assn. A record of tests planned to determine the resistance of freight trains under the usual conditions of operation. 1200 w. Am Engr & R R Jour—July, 1910. No. 15479 C.

Wheels.

Unevenly Chilled and Untrue Car Wheels. Thomas D. West. Read before the Am. Soc. for Test. Mat. Explains existing defects and proposes a method of correcting them. 1500 w. Ir Age—June 30, 1910. No. 15304.

NEW PROJECTS.

Cape-to-Cairo.

Present Situation and Prospects of the Cape-to-Cairo Railway (Stand und Aus-

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sichten der Kap-Kairo-Bahn). Richard Hennig. A review of work already done and of plans for the completion of the line. Ills. 3000 w. Tech u Wirt—June, 1910. No. 15961 D.

Mexico.

The Southern Pacific of Mexico Railroad. L. A. Waterbury. Illustrates and describes a railway system which will connect the City of Mexico with the western portion of the United States. 2000 w. Eng News—July 28, 1910. No. 16025.

Switzerland.

The Bernese Alpine Railway (Berner-Alpenbahn). A. Zollinger. Describes the line which includes the Lötschberg tunnel. Ills. Serial. 1st part. 2000 w. Schweiz Bau—June 18, 1910. No. 15908 B.

PERMANENT WAY AND BUILDINGS.

Bridges.

Report No. 10 for Austria and Hungary on the Question of Stengthening the Bridges with a View to Increasing the weight of Locomotives and the Speed of Trains. M. Maurer. Discusses the suitable strengthening of existing metal bridges proportionately to the increase in weight of locomotives and speed of trains. Ills. 17600 w. Bul Int Ry Cong—June, 1910. No. 15992 G.

Construction.

Copper River and Northwestern Railroad, Alaska. L. W. Storm. Describes a 200 mile railroad under construction at a cost of $13,000,000, and the difficulties encountered. Ills. 3000 w. Eng & Min Jour—July 9, 1910. No. 15464.

Open Cuts.

Erie's Four-Track Open Cut. Illustrated account of the construction of the open cut through Bergen Hill, Jersey City, to be used instead of the tunnel, for passenger service. 1000 w. Ry & Loc Engng—July, 1910. No. 15328 C.

Round Houses.

American Locomotive Terminals. William Forsyth. Gives general plan of the East Altoona, Pa., engine house with description of the oganization and work. 3500 w. Jour Am Soc of Mech Engrs—July, 1910. No. 15838 F.

Engine House Practice, or the Handling of Locomotives at Terminals to Secure Continuous Operation. F. H. Clark. Describes features of design and equipment considered good practice in the United States. Ills. 2500 w. Jour Am Soc of Mech Engrs—July, 1910. No. 15837 F.

Handling Locomotives at Terminals. Frederic M. Whyte. Discusses practice along certain lines in the United States and Canada, with suggestions. 6000 w. Jou Am Soc of Mech Engrs—July, 1910. No. 15836 F.

Terminals.

Design of Terminals for Mechanical Freight Handling. H. McL. Harding. Editorial letter, explaining the advantages of the overhead method, and offering suggestions. 2500 w. Ry & Engng Rev—July 2, 1910. No. 15292.

New Chicago Station of the Chicago & North Western. An illustrated article giving some facts relating to the construction of one of the largest terminals in the United States. 3000 w. Ry Age Gaz—July 15, 1910. No. 15615.

See also New York, under CIVIL ENGINEERING, WATERWAYS AND HARBORS.

Track Construction.

Report No. 9, for All Countries Except Austria, Hungary, Bulgaria, Roumania, Servia, Turkey, America, and Great Britain, on the Question of Stengthening the Track with a View to Increasing the Weight of Locomotives and the Speed of Trains. M. Blum. 7200 w. Bul Int Ry Cong—June, 1910. No. 15995 G.

See also Earthwork, under CIVIL ENGINEERING, CONSTRUCTION.

Track Maintenance.

Methods and Costs of Surfacing and Smoothing Track. D. A. Wallace. Suggestions and records of work. 2500 w. Engng-Con—July 27, 1910. No. 16018.

Turntables.

Turntable for Mallet Locomotives. Illustrated description of a motor-driven transfer type turntable designed by Frank H. Adams. 700 w. Ry Age Gaz—July 1, 1910. No. 15365.

TRAFFIC.

Bills of Lading.

The Bills of Lading Controversy. Discusses the bill for making railway companies liable for the acts of their agents in issuing order bills of lading. 2500 w. Ry Age Gaz—July 15, 1910. No. 15612.

Car Distribution.

Car Distribution. N. D. Ballantine. Condensed from a lecture to the students of "Railway Economics," Univ. of Mich. Discusses the problems of this service, the requirements, etc. 4800 w. Ry Age Gaz—July 15, 1910. No. 15610.

Car Interchange.

Interchange of Freight Cars on the Basis of Master Car Builders' Rules of Interchange vs. Run, Repair or Transfer. R. L. Kleine. A study of the question, introducing a general discussion. 21500 w. Pro Ry Club of Pittsburgh—April 22, 1910. No. 15816 C.

Freight Damages.

Loss and Damage—Causes and Remedies. Otto Best. Abstract of an address before the Nashville, Tenn., Assn. of R. R. Officers. Follows a shipment of merchandise from loading station to destination, pointing out the causes of waste and loss. 2500 w. Ry Age Gaz—July 8, 1910. No. 15470.

Locomotive Pooling.

Handling Engines. H. H. Vaughan. Discuesses the desirability of pooling in

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passenger and in freight service. 1800 w. Jour Am Soc of Mech Engrs—July, 1910. No. 15839 F.

Perishable Freight.

Report No. 2, for All Countries Except those Using the English Language, on the Question of Perishable Goods. Richard Bloch. Considers suitable measures for developing the traffic in perishables. 46500 w. Bul Int Ry Cong—June, 1910. No. 15993 G.

MISCELLANY.

Abyssinia.

The Djibouti-Addis-Abera Railway (Note sur la Ligne de Djibouti à Addis-Abeba). R. Godfernaux. Describes in detail the construction and operation of the first railway in Abyssinia. Ills. 8000 w. Rev Gen d Chemins de Fer—June, 1910. No. 15715 G.

Australia.

Australia's Railway System and Some of Its Problems. Jas. Alex. Smith. Extracts from a presidential address to the Victorian Inst. of Engrs. under the title "National Issues in Australian Railway Engineering." 3500 w. Eng News—July 14, 1910. No. 15590.

Holland.

Transportation and Traffic in Holland. Logan G. M'Pherson. A preliminary report to the Nat. Waterways Com. Facts in regard to the transportation and traffic and the revenues of the operating companies. 2000 w. Ry Age Gaz—July 29, 1910. No. 16041.

International Congress.

International Railway Congress. A report of the meeting in Berne, Switzerland, which opened July 5th. 2500 w. Engr, Lond—July 8, 1910. Serial. 1st part. No. 15681 A.

Management.

Deadwood in Railway Service. N. F. Dougherty. Discussion of employees below the position of superintendent, and the importance of worth selection instead of chance selection. 2500 w. Ry Age Gaz—July 22, 1910. No. 15830.

Profits.

Profits of American Railways, as Illustrated by the Illinois Central. Howard G. Brownson. A study of the cash investment and the profits made. 6000 w. Ry Age Gaz—July 1, 1910. No. 15360.

Scandinavia.

Scandinavian Railways (Auf skandinavischen Eisenbahnen). Herr von Mühlenfels. A general description of the railway sytems of Sweden and Norway. Ills. 14000 w. Glasers Ann—June 15, 1910. No. 15924 D.

STREET AND ELECTRIC RAILWAYS.

Brake Shoes.

Brake Shoe Standardization. J. A. Panton. Abstract of a paper before the Tram. & Lgt. Ry's. Assn. Calls attention to waste in connection with brake heads and blocks, and discusses the properties of various types of brake blocks, suggesting a standard design. 4000 w. Elect'n, Lond—June 24, 1910. No. 15517 A.

Canal Haulage.

Novel Electric Towing Locomotive for Canal Locks. Herbert Brackett. Illustrates and describes the novel locomotive by which vessels are towed through the Bremen locks. 700 w. Sci Am—July 9, 1910. No. 15415.

Capacity.

A Method for Determining the Adequacy of an Electric Railway System. R. W. Harris. A study of practical working conditions during the peak periods. 5000 w. Pro Am Inst of Elec Engrs—July, 1910. No. 15275 F.

Car Barns.

Car Depot of the Paris Tramways Company. Illustrated detailed description. 2500 w. Tram & Ry Wld—July 7, 1910. No. 15895 B.

Car Wheels.

The Latest Development in Car Wheels for Electric Railways. V. S. Yarnell. Read at meeting of St. Ry. Assn. of N. Y. State. Describes the methods of manufacture employed by the Carnegie Steel Co. in the manufacture of Schoen solid forged and rolled steel wheels. 2500 w. Elec Ry Jour—July 2, 1910. No. 15317.

Controllers.

Recent Developments in Multiple-Unit Control and Other Electric Railway Apparatus. Clarence Renshaw. Abstract of a paper read before the St. Ry. Assn. of N. Y. State. Explains the advantages of multiple-unit control, and illustrates and describes apparatus. 2500 w. Elec Ry Jour—July 2, 1910. No. 15320.

Detroit.

See Valuation, under STREET AND ELECTRIC RAILWAYS.

Feeders.

See Line Design, under ELECTRICAL ENGINEERING, TRANSMISSION.

Hamburg.

The Hamburg City and District Railways (Die Hamburger elektrischen Stadt- und Vorortebahnen). E. A. Ziffer. A brief description of their extent and operation. Ills. 5000 w. Mit d Ver f d Förd d Lokal u Strassenbahnwesens—June, 1910. No. 15760 F.

Headlights.

Headlight-Tests. C. Francis Harding

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and A. N. Topping. A report of tests carried out by the Engineering Schools of Purdue University to determine the effect of powerful headlights upon the interpretation of signals and on the ability to recognize obstacles upon the tracks. 8000 w. Pro Am Inst of Elec Engrs—July, 1910. No. 15281 F.

Interurban.

Winnipeg, Selkirk & Lake Winnipeg Interurban Railway. Brief illustrated description. 1600 w. Elec Ry Jour—July 2, 1910. No. 15316.

The 1200-Volt D. C. Interurban Lines of the Milwaukee Electric Railway & Light Company. Illustrated description of the scheme of electrification, rolling stock, substations, and construction. 3500 w. Elec Ry Jour—July 16, 1910. No. 15606.

Locomotives.

The Design of the Electric Locomotive. N. W. Storer and G. M. Eaton. A statement of the problem as viewed by the authors, discussing a few of the fundamental principles on which the design should be based. Ills. 8500 w. Pro Am Inst of Elec Engrs—July, 1910. No. 15283 F.

Edison Electric Locomotive No. 2. Frederick A. Scheffler. Illustrated description. 1200 w. Elec Rev, N Y—July 23, 1910. No. 15868.

Steam Turbine Electric Locomotive. Illustrated description of the Reid-Ramsay turbo-electric locomotive. 700 w. Engr, Lond—July 8, 1910. No. 15683 A.

The Reid-Ramsay Electro-Turbo Locomotive. Illustrations with brief description. 300 w. Engng—July 8, 1910. No. 15674 A.

See also Canal Haulage, under STREET AND ELECTRIC RAILWAYS.

Melbourne.

Melbourne Electric Transit. An illustrated account of the Prahran-Malvern tramway, recently completed at a cost of £87,000. 3000 w. Aust Min Stand—May 25, 1910. No. 15503 B.

Monorail.

The Elementary Theory of the Gyroscope in the Brennan Monorail Car. Edward V. Huntington. A clear statement of the elementary principles of the gyroscope, and its application to the Brennan monorail car. Ills. 4000 w. Eng News—July 21, 1910. No. 15804.

Motor Gears.

Railway Motor Gears and Pinions. T. W. Williams. Abstract of a paper read at meeting of the St. Ry. Assn. of N. Y. State. Investigates causes of rapid wear and means of strengthening. 3000 w. Elec Ry Jour—July 2, 1910. No. 15318.

Operation.

Regulation of Transportation Service by the Metropolitan Street Railway, New York. A description of the transportation service and its regulation. 5500 w. Elec Ry Jour—July 2, 1910. No. 15315.

Improved Operation of the Brooklyn Bridge. Explains changes that have brought about excellent results in expediting the congested traffic. Also editorial. 3000 w. Eng Rec—June 11, 1910. No. 14690.

Power Economy in Electric Railway Operation—Coasting Tests on the Manhattan Railway, New York. H. St. Clair Putnum. Describes tests made on the Manhattan Elevated Division, New York, in which a clock was used to record the amount of coasting employed, the object being to obtain a better manipulation of the trains with resulting economy in the use of power. 4500 w. Pro Am Inst of Elec Engrs—July, 1910. No. 15276 F.

Economy of Car Operations. Cyril J. Hopkins. Aims to show quantitatively the value of coasting in terms of change in average speed, and running time, and to discuss the value of anti-friction bearings. Ills. 4000 w. Pro Am Inst of Elec Engrs—July, 1910. No. 15277 F.

Service.

The Street Railways of Some German Cities and of Some American Cities. A comparison of the service, to the disadvantage of American lines. 3500 w. Eng News—July 28, 1910. No. 16029.

Single-Phase.

The Single-Phase Railway Between Rotterdam, the Hague, and Scheveningen. C. Van Langendonck. Illustrated description. 2000 w. Ry Age Gaz—July 8, 1910. No. 15471.

Subways.

Boston Elevated Railroad Company's New Tunnel. Illustrates and describes the uses made of electricity in the construction of the Cambridge subway. 4000 w. Elec Wld—July 28, 1910. No. 16019.

Report on Pittsburgh Subway. Bion J. Arnold. Abstract of a preliminary report on the possibilities for rapid transit. 2000 w. Ry Age Gaz—July 22, 1910. No. 15832.

Track Construction.

Standardization of Track Construction in Paved Streets. Benjamin E. Tilton. Abstract of paper read before the St. Ry. Assn. of N. Y. State. Discusses the foundation, substructure, and superstructure, and the general standards appliable to cities of ordinary size. 3000 w. Elec Ry Jour—July 2, 1910. No. 15319.

Trolley Lines.

Brooklyn Line Department—Efficiency Features of Construction and Maintenance. Illustrates and describes the construction used for the ordinary type of overhead trolley lines, with an explanation of the system of records. 2000 w. Elec Ry Jour—July 23, 1910. No. 15823.

Valuation.

The Appraised Value of the Electric Street Railways of Detroit, Mich. Abstract of the report of Frederick T. Barcroft. 3500 w. Engng-Con—July 6, 1910. No. 15495.

We supply copies of these articles. See page 966.

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We hold ourselves ready to supply—usually by return of post—the full text of every article indexed in the preceding pages, *in the original language*, together with all accompanying illustrations; and our charge in each case is regulated by the cost of a single copy of the journal in which the article is published. The price of each article is indicated by the letter following the number. When no letter appears, the price of the article is 20 cts. The letter A, B, or C denotes a price of 40 cts.; D, of 60 cts.; E, of 80 cts.; F, of $1.00; G, of $1.20; H, of $1.60. When the letter N is used it indicates that copies are not readily obtainable and that particulars as to price will be supplied on application. Certain journals, however, make large extra charges for back numbers. In such cases we may have to increase proportionately the normal charge given in the Index. In ordering, care should be taken to *give the number* of the article desired, not the title alone.

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THE PUBLICATIONS REGULARLY REVIEWED AND INDEXED

The titles and addresses of the journals regularly reviewed are given here in full, but only abbreviated titles are used in the index. In the list below, *w* indicates a weekly publication, *b-w*, a bi-weekly, *s-w*, a semi-weekly, *m*, a monthly, *b-m*, a bi-monthly, *t-m*, a tri-monthly, *qr*, a quarterly, *s-q*, semi-quarterly, etc. Other abbreviations used in the index are: Ill—Illustrated; W—Words; Anon—Anonymous.

Alliance Industrielle. *m.* Brussels.
American Architect. *w.* New York.
Am. Engineer and R. R. Journal. *m.* New York.
American Jl. of Science. *m.* New Haven, U. S. A.
American Machinist. *w.* New York.
Anales de la Soc. Cien. Argentina. *m.* Buenos Aires.
Annales des Ponts et Chaussées. *m.* Paris.
Ann. d Soc. Ing. d Arch Ital. *s-m.* Rome.
Architect. *w.* London.
Architectural Record. *m.* New York.
Architectural Review. *s-q.* Boston.
Architect's and Builder's Magazine. *m.* New York.
Australian Mining Standard. *w.* Melbourne.
Autocar. *w.* Coventry, England.
Automobile. *w.* New York.
Automotor Journal. *w.* London.
Beton und Eisen. *qr.* Vienna.
Boiler Maker. *m.* New York.
Brass World. *m.* Bridgeport, Conn.
Brickbuilder. *m.* Boston.
Builder. *w.* London.
Bull. Bur. of Standards. *qr.* Washington.
Bulletin de la Société d'Encouragement. *m.* Paris.
Bulletin of Dept. of Labor. *b-m.* Washington.
Bull. of Can. Min. Inst. *qr.* Montreal.
Bull. Soc. Int. d'Electriciens. *m.* Paris.
Bulletin of the Univ. of Wis., Madison, U. S. A.
Bull. Int. Railway Congress. *m.* Brussels.
Bull. Scien. de l'Assn. des Elèves des Ecoles Spéc. *m.* Liége.
Bull. Tech. de la Suisse Romande. *s-m.* Lausanne.
California Jour. of Tech. *m.* Berkeley, Cal.
Canadian Architect. *m.* Toronto.
Canadian Electrical News. *m.* Toronto.
Canadian Engineer. *w.* Toronto and Montreal.
Canadian Mining Journal. *b-w.* Toronto.
Cassier's Magazine. *m.* New York and London.
Cement. *m.* New York.
Cement Age. *m.* New York.
Central Station. *m.* New York.
Chem. Met. Soc. of S. Africa. *m.* Johannesburg.
Clay Record. *s-m.* Chicago.
Colliery Guardian. *w.* London.
Commercial Vehicle. *m.* New York.

Compressed Air. *m.* New York.
Comptes Rendus de l' Acad. des Sciences. *w.* Paris.
Cornell Civil Engineer. *m.* Ithaca.
Deutsche Bauzeitung. *b-w.* Berlin.
Die Turbine. *s-m.* Berlin.
Domestic Engineering. *w.* Chicago.
Economic Geology. *m.* New Haven, Conn.
Electrical Age. *m.* New York.
Electrical Engineer. *m.* London.
Electrical Engineering. *w.* London.
Electrical Review. *w.* London.
Electrical Review. *w.* New York.
Electric Journal. *m.* Pittsburg, Pa.
Electric Railway Journal. *w.* New York.
Electrical World. *w.* New York.
Electrician. *w.* London.
Electricien. *w.* Paris.
Elektrische Kraftbetriebe u Bahnen. *w.* Munich.
Elektrochemische Zeitschrift. *m.* Berlin.
Elektrotechnik u Maschinenbau. *w.* Vienna.
Elektrotechnische Rundschau. *w.* Potsdam.
Elettricità. *w.* Milan.
Engineer. *w.* London.
Engineering. *w.* London.
Engineering-Contracting. *w.* New York.
Engineering Magazine. *m.* New York and London.
Engineering and Mining Journal. *w.* New York.
Engineering News. *w.* New York.
Engineering Record. *w.* New York.
Eng. Soc. of Western Penna. *m.* Pittsburg, U. S. A.
Foundry. *m.* Cleveland, U. S. A.
Génie Civil. *w.* Paris.
Giesserei-Zeitung. *s-m.* Berlin.
Glasers Ann. f Gewerbe & Bauwesen. *s-m.* Berlin.
Heating and Ventilating Mag. *m.* New York.
Horseless Age. *w.* New York.
Ice and Cold Storage. *m.* London.
Ice and Refrigeration. *m.* New York.
Il Cemento. *s-m.* Milan.
Industrial World. *w.* Pittsburg.
Ingegneria Ferroviaria. *s-m.* Rome.
Ingenieur. *w.* Hague.
Insurance Engineering. *m.* New York.
Int. Marine Engineering. *m.* New York.
Iron Age. *w.* New York.
Iron and Coal Trades Review. *w.* London.
Iron Trade Review. *w.* Cleveland, U. S. A.
Jour. of Accountancy. *m.* N. Y.
Journal Asso. Eng. Societies. *m.* Philadelphia.
Journal Franklin Institute. *m.* Philadelphia.
Jour. N. E. Water Works Assn. *qr.* Boston.
Journal Royal Inst. of Brit. Arch. *s-q.* London.
Jour. Roy. United Service Inst. *m.* London.
Journal of Sanitary Institute. *qr.* London.
Jour. of South African Assn. of Engineers. *m.* Johannesburg, S. A.
Journal of the Society of Arts. *w.* London.
Jour. Transvaal Inst. of Mech. Engrs., Johannesburg, S. A.
Jour. of U. S. Artillery. *b-m.* Fort Monroe, U. S. A
Jour. W. of Scot. Iron & Steel Inst. *m.* Glasgow.
Journal Western Soc. of Eng. *b-m.* Chicago.
Jour. of Worcester Poly. Inst., Worcester, U. S. A.
Locomotive. *m.* Hartford, U. S. A.
Machinery. *m.* New York.
Manufacturer's Record. *w.* Baltimore.
Marine Review. *m.* Cleveland, U. S. A.
Mechanical Engineer. *w.* London.
Mechanical World. *w.* Manchester.
Mem. de la Soc. des Ing. Civils de France. *m.* Paris.
Metallurgical and Chem. Engng. *m.* New York.
Métallurgie. *w.* Paris.
Metal Worker. *w.* New York.
Mines and Minerals. *m.* Scranton, U. S. A.
Mining and Sci. Press. *w.* San Francisco.
Mining Journal. *w.* London.
Mining Magazine. *m.* London.
Mining World. *w.* Chicago.
Mittheilungen des Vereins für die Förderung des Local- und Strassenbahnwesens. *m.* Vienna.
Municipal Engineering. *m.* Indianapolis, U. S. A.
Municipal Journal and Engineer. *w.* New York.
Nautical Gazette. *w.* New York.
New Zealand Mines Record. *m.* Wellington.
Oest. Wochensch. f. d. Oeff. Baudienst. *w.* Vienna.
Oest. Zeitschr. Berg- & Hüttenwesen. *w.* Vienna.
Plumber and Decorator. *m.* London.
Power and The Engineer. *w.* New York.
Practical Engineer. *w.* London.
Pro. Am. Ins. Electrical Eng. *m.* New York.
Pro. Am. Ins. of Mining Eng. *m.* New York.
Pro. Am. Soc. Civil Engineers. *m.* New York.
Pro. Am. Soc. Mech. Engineers. *m.* New York.
Pro. Canadian Soc. Civ. Engrs. *m.* Montreal.
Proceedings Engineers' Club. *qr.* Philadelphia.
Pro. Engrs. Soc. of Western Pennsylvania. *m.* Pittsburg.
Pro. St. Louis R'way Club. *m.* St. Louis, U. S. A.
Pro. U. S. Naval Inst. *qr.* Annapolis, Md.
Progressive Age. *s-m.* New York.
Public Works. *qr.* London.
Quarry. *m.* London.
Queensland Gov. Mining Jour. *m.* Brisbane, Australia.
Railway Age Gazette. *m.* New York.
Railway and Engineering Review. *w.* Chicago.
Railway and Loc. Engng. *m.* New York.
Railway Master Mechanic. *m.* Chicago.
Revue d'Electrochimie et d'Electrométallurgie. *m.* Paris.
Revue de Mécanique. *m.* Paris.
Revue de Métallurgie. *m.* Paris.
Revue Gén. des Chemins de Fer. *m.* Paris.
Revue Gén. des Sciences. *w.* Paris.
Revue Industrielle. *w.* Paris.
Rivista Marittima. *m.* Rome.
Rudder. *m.* New York.
Schiffbau. *s-m.* Berlin.
School of Mines Quarterly. *q.* New York.
Schweizerische Bauzeitung. *w.* Zürich.
Scientific American. *w.* New York.
Scientific Am. Supplement. *w.* New York.
Sibley Jour. of Mech. Eng. *m.* Ithaca, N. Y.
Signal Engineer. *m.* Chicago.
Soc. Belge des Elect'ns. *m.* Brussels.
Stahl und Eisen. *w.* Düsseldorf.
Stevens Institute Indicator. *qr.* Hoboken, U. S. A.
Surveyor. *w.* London.
Technik und Wirtschaft. *m.* Berlin.
Technique Moderne. *m.* Paris.
Tramway & Railway World. *m.* London.
Trans. Inst. of Engrs. & Shipbuilders in Scotland, Glasgow.
Wood Craft. *m.* Cleveland, U. S. A.
Yale Scientific Monthly. *m.* New Haven.
Zeitschr. f. d. Gesamte Turbinenwesen. *w.* Munich.
Zeitschr. d. Mitteleurop. Motorwagen. Ver. *s-m.* Berlin.
Zeitschr. d. Oest. Ing. u. Arch. Ver. *w.* Vienna.
Zeitschr. d. Ver. Deutscher Ing. *w.* Berlin.
Zeitschr. f. Werkzeugmaschinen. *b-w.* Berlin.

CURRENT RECORD OF NEW BOOKS

NOTE—Our readers may order through us any book here mentioned, remitting the publisher's price as given in each notice. Checks, Drafts, and Post Office Orders, home and foreign, should be made payable to THE ENGINEERING MAGAZINE.

Corrosion.

The Corrosion and Preservation of Iron and Steel. By Allerton S. Cushman and Henry A. Gardner. Size, 9 by 6 in.; pp., 373. Ills. Price, $4. New York: McGraw-Hill Publishing Company.

A large part of this work is devoted to the presentation of the results of Dr. Cushman's researches in the laboratory of the United States Office of Public Roads which led to the formulation of the electrolytic theory of corrosion. All of this material has already been published in official bulletins but not in such complete detail as in the present volume. Dr. Cushman's collaborator is Director of the Scientific Section of the Paint Manufacturers' Association of the United States. The practical application of the electrolytic theory of corrosion to the problem of preservation is clearly demonstrated, and the second part of the book summarizes present knowledge as to the properties of the various pigments, paints and other protective coatings as stimulators or inhibitors of corrosion. The chapter headings are: The Problem of Corrosion; Theory of Solution; Theory of Corrosion; Application of Electrolytic Theory; The Inhibition and Stimulation of Corrosion; The Technical Protection of Iron and Steel; Relation of Pigments to the Corrosion of Iron; Recent Field Tests on Protective Coatings for Iron and Steel; Paints for Various Purposes; The Testing and Design of Protective Paints; Properties of Pigments; and The Properties of Paint Vehicles. Appendices give a bibliography and a report of a discussion before the American Institute of Mining Engineers on the Corrosion of Water Jackets of Copper Blast Furnaces. The volume is appropriately dedicated to the memory of Dr. Charles B. Dudley.

Roads.

Dust Preventives and Road Binders. By Prévost Hubbard. Size, 9 by 6 in.; pp., 416. Ills. Price, $3, 12/6. New York: John Wiley & Sons; London: Chapman & Hall.

This timely work aims to furnish road engineers with a working knowledge of the characteristic properties of dust preventives and road binders now in use, and to develop certain fundamental principles relative to their selection and application. The conclusions presented are based upon five years' field and laboratory experience as Assistant Chemist in the United States Office of Public Roads. The author admits that practice in dust prevention has not yet been standardized, that there is much yet to be learned regarding the effect of certain properties of road binders upon their practical usefulness. It is unquestionable, however, that an authoritative summary of the established facts was needed, which the present volume seems adequately to offer.

Shop Practice.

Engineering Workshop Machines and Processes. By F. zur Nedden. Translated and Revised by John A. Davenport. Size, 8¾ by 5½ in.; pp., 216. Ills. Price, $2. New York: D. Van Nostrand Company.

The sub-title, "A Handbook for the Use of Students and Others Taking the Workshop Training Recommended by the Institution of Civil Engineers," indicates the scope of this work. It is a translation and adaptation to suit the needs of English engineering apprentices of certain parts of a German work written to assist during their "practical year" the "volunteers" who, in the German educational system, interpolate twelve months' workshop experience between school and university. The intention of the author and translator has been to set out in a condensed but intelligible form those matters which a young engineer entering a shop for the first time will frequently find to be assumed by those around him in the shop as known already. The subjects dealt with, after a brief introductory chapter on the efficiency of engines and machines, include: the modern engineering works; materials of construction; foundry and pattern shop; forging; the machine shop; measuring and marking-off; and fitting, erecting and testing. An introduction is contributed by Sir Alexander B. W. Kennedy, and an appendix contains the report on the education and training of engineers adopted by the Council of the Institution of Civil Engineers.

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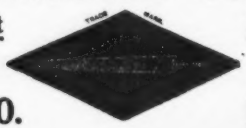

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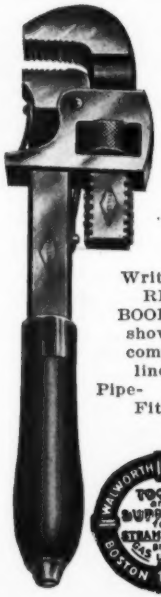

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THE ENGINEERING MAGAZINE

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Vol. XXXIX, No. 6

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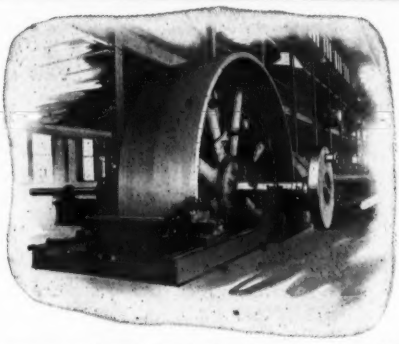

The Wheels of Power and Their Relation to the Wheels of Progress

The earth revolves on its own axis—

Not being satisfied with that, it revolves around the sun as well—

It never rests—it keeps going all the time—there's no let up—

And taking mother earth for a guide, as a shining example—

We mortals strive in our own way to come as near to the example set as possible.

Yet we are not all built alike.

Which accounts for the fact that there are leaders and followers—the leaders striving just a little harder than anybody else to progress, to go existing things one better—while the followers, content to let the leaders do the worrying, the experimenting, the testing, and when *they* succeed, *copy* their achievements—

Which accounts for Geo. H. Corliss—a leader of large calibre—a born mover, a shining disciple of mother earth, a progressor in other words—

Which also accounts for the horde of followers, engine builders lacking the progressive movement, content to copy the original Corliss intact, the moment the Corliss patent expired.

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AUTHORS AND PAPERS FOR SEPTEMBER, 1910

CHARLES DAY (*The Routing Diagram as a Basis for Laying Out Industrial Plants*)—Born 1879; graduated University of Pennsylvania (B.S.) 1899; took degree of M. E. on thesis 1901; superintendent installation of power-plant equipment and transmission machinery, Philadelphia Export Exposition; at its close entered employ of Link Belt Engineering Co., as assistant to superintendent and later engineer of works. After this plant had been thoroughly modernized, he and Mr. Dodge opened an office specializing on shop equipment and management; later, the scope of the organization was enlarged to include a great deal of engineering and construction work in both the industrial and public-service fields. Two years ago Mr. John E. Zimmermann became a partner in the firm of Dodge & Day. Member Am. Soc. Mech. Engineers, member of the Board of Managers and chairman mechanical engineering section of the Franklin Institute, associate member Am. Inst. E. E., member New York Electrical Society, Philadelphia Engineers' Club, and Engineers' Club and Machinery Club, New York.

ILLUSTRATIONS (*The New Building of the Institution of Civil Engineers*)—

FRANK KOESTER (*A General Review of Hydroelectric-Engineering Practice*)—Acquired a thorough practical and technical education on the Continent and devoted four years to field and shop work and several years to work in the designing department and in general engineering and the power department of the Siemens-Schuckert Works, Germany; moved to the United States in 1902 and entered the engineering department of the Interborough Rapid Transit Co., New York; later became associated with J. G. White & Co., New York, in the design of various power plants under their charge; was later engaged upon the design of a Chilean hydro-electric plant and transmission system in connection with a copper concentrating works; author of "Steam Electric Power Plants" and "Hydro-Electric Developments and Engineering."

HARRINGTON EMERSON (*The Twelve Principles of Efficiency*)—Born in Trenton, New Jersey, 1853. Educated in Europe, receiving the degree of M. A. at the Royal Polytechnic at Munich, Bavaria; professor at the State University of Nebraska, 1875; engaged in engineering work on the Burlington & Missouri R. R. in 1886, and later engaged in making many inspections and preparing reports on important engineering and mining work in the United States, Mexico and Alaska. Recently with the American Locomotive Company in a similar capacity; originated and developed the efficiency system of wage payment. Consulting engineer, the Emerson Company, New York City.

F. PERCIVAL (*Government Specifications. An Example of Neglect of Three Efficiency Principles*)—An author whose long and intimate connection with American Government undertakings enables him to speak with certainty and accuracy, but at the same time prohibits further disclosure of his identity.

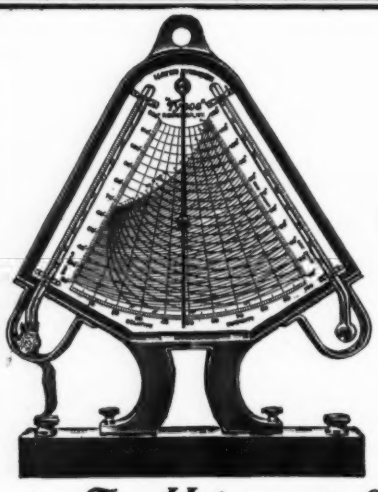
VICTOR R. CLAYDON (*Time Keeping and Labour Distribution in the Foundry*)—Born Thame, Oxfordshire; educated at Kent College, Canterbury, Kent, going thence to London as clerk in a large business house; for three and a half years past has been in Canada, and for two years of this time with Messrs. Warden King, Ltd., whose foundry employs about 500 men in the manufacture of hot-water

and steam furnaces, steam fittings, soil pipe, and soil-pipe fittings with a daily melt of about 50 tons; Mr. Claydon has been associated with their present cost system from the beginning, as timekeeper and foundry clerk, and now as compiler of final cost reports after receipt of the time distributions and reports of materials; the plant in which he is employed is one of the largest and best equipped in Canada.

PERCIVAL ROBERT MOSES (*The Heating, Ventilating and Air-Conditioning of Factories*)—Born in New York; educated in Europe and in the United States; entered the School of Mines of Columbia College in 1891 and graduated in 1895-6 with the degree of Electrical Engineer; was for some time with the Sprague Electrical Company in factory and construction work; practising as consulting engineer in New York since 1898; member of the American Institute of Electrical Engineers.

WARREN H. MILLER (*French Aeroplane Motors*)—Graduated Stevens Institute of Technology; has been associated for fifteen years with various manufacturing establishments, including the Fairbanks-Morse Co., the C. C. C. & St. L. Railroad Co. and the Standard Oil Co., having been industrial engineer for the last-named corporation for five years past; his work has included power installations and drives, power distribution by electricity, compressed air, and shafting, forge-shop and woodworking equipments and patent applications; he installed the power and electric equipments for the chemical department of the Standard Oil Co. at Bayonne, the refineries at Cleveland, Baton Rouge, and Bay Way, and more recently went abroad to investigate the latest developments in gas-engine practice and the use of superheated steam; attended by invitation the aviation conference at the Sorbonne, Paris, and also made a special study of Continental forestry practice.

HENRY HESS (*Manufacturing Profits and Losses*)—Born 1863; mechanical engineer; largely identified with the development of heavy machine-tool design in the United States, one of his productions being a milling machine which marked a long step forward in rapid working and shop economy, raising the record for fast feeding several fold. Experience comprises actual practical work in machine shops, machine design, works design, and management. Has made a special study of questions relating to economical production. Was at one time designer and later general managing director of the German Niles Tool Works Company at Berlin, Germany; afterwards engaged in the manufacture of machine tools in Philadelphia, Pa. Now President of the Hess-Bright Manufacturing Company manufacturing ball and roller bearings; member A. S. M. E.



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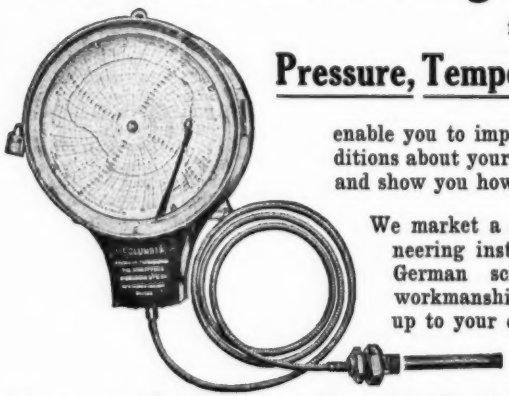

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Wheeler Condenser & Engng. Co. 81
White & Co., J. G. 29
Wilder Co., Chas. 73
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Williams Bros. 95
Williams, Franklin 87
Williams, Brown & Earle, Inc. 10
Williams Gauge Co. 52
Wing Mfg. Co., L. J. 34
Wisconsin Engine Co. 6
Wood & Co., R. D. 54
Worcester Polytechnic Institute 31
Wright Mfg. Co. 82
Wyman & Gorden Co. 124

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"AMERICAN"

A Valuable Text Book on Rope Driving

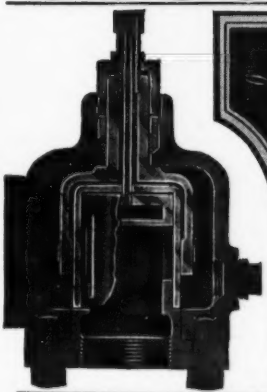
Chapters on the advantages of Manila Rope for the transmission of power, on systems of arranging drives, data on sheaves, directions for splicing, formula and data for calculating drives, practical notes on the care of ropes and a detailed description of the many superior qualities of

"American" Transmission Rope

Copies Free

The American Manufacturing Co.
65 Wall Street, New York City

TRANSMISSION ROPE



ROTHCHILD ROTARY GATE VALVE

THE ROTHCHILD ROTARY-GATE VALVE

Notice the stress we place on the word **Rotary?** That's where our valve differs **from all other** valves.

Study the accompanying illustration and note the Radically Reversed Principles embodied in its design. You can clearly see how this valve will positively **hold** steam, water, gas, ammonia, air, oil or other fluids **hot** or **cold.** A strong point is its value as a high-pressure Boiler Blow-off. There is absolutely no danger of sediment or scale becoming lodged between the valve and its seat. Everything has "got to keep moving" in this **Rotary** Gate Valve. Another valuable feature is its ability to take up its own wear, automatically—**By Pressure Alone.** It **will not** leak and requires no repairs or adjustment. **This we guarantee.** There are many more points that show their economy, long life and efficiency that we will send you in booklet form. Your address, please?

JOHN SIMMONS CO. 102-110 CENTRE ST., NEW YORK

Countershaft Belts that Have Lasted 28 Years.

In 1882 we installed in a textile mill a 12 inch, a 14 inch and a 16 inch double. They are still running, and look as though they would last for ten years longer.

Unusually low cost per day is shown by

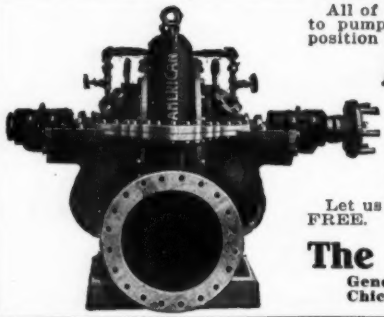
RHOADS LEATHER BELTING.

Write for our belt record forms.

J. E. RHOADS & SONS

Philadelphia: 12 N. Third St. **New York: 40 Fulton St.**
Chicago: 243 E. Randolph St.
Factory and Tannery: Wilmington, Del.

2 Grand Prizes and 5 Gold Medals



All of the Grand Prizes and all of the Gold Medals given to pumping machines by the Alaska-Yukon-Pacific Exposition at Seattle, last summer, were awarded to

American Pumping Machinery

The reason why "American" centrifugal pumps attain higher efficiencies than others is that they have the best possible flow lines with no sudden change of direction of fluid in passing through the pump, and the impellers are accurately machined to the casing, preventing back flow.

Let us solve your pumping problems. Complete Catalog FREE.

The American Well Works

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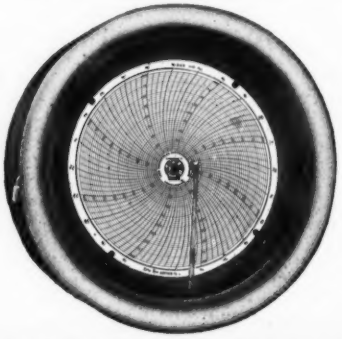
Chicago Office: First National Bank Building.

Within reach of every steam user

Remarkable for its many practical improvements, the New **Industrial Recording Steam Gauge** can yet be furnished at a price the smallest plant can afford.



It saves coal; helps the fireman; tells the whole story. Specimen Chart B-37 will illustrate our point. Get one.

THE INDUSTRIAL INSTRUMENT CO.

Sales Company for the Standard Gauge Mfg. Co.

New York, 50 Church St. **FOXBORO, MASS., U. S. A.** Chicago, Monadnock Bldg.

The Buyers' Directory

OF

The Engineering and Machinery Trades

NOTE—*The display advertisement of the firms mentioned under each heading can be found readily by reference to the Alphabetical Index.* *See page 11.*

Abrasive Material (Alundum).
Norton Co., Worcester, Mass.

Abrasive Materials.
Carborundum Co., Niagara Falls, N.Y.

Accumulators, Hydraulic.
Niles-Bement-Pond Co., New York.
Sellers & Co., Inc., William, Phila.
Watson-Stillman Co., New York.
Wood & Co., R. D., Phila., Pa.

Acid Proof Coating
Glidden Varnish Co., Cleveland.

Advertising.
Manufacturers' Publicity Corp., N. Y.

Aerial Tramways.
Flory Mfg. Co., S., Bangor, Pa.
Lambert Hoist. Eng. Co., Newark.
Lidgerwood Mfg. Co., New York.

Air and Gas Compressors.
American Compressor & Pump Co., New York.
Curtis & Co., Mfg. Co., St. Louis.
De La Vergne Mach. Co., New York.
Ingersoll-Rand Co., New York.
McGowan Co., John H., Cincinnati.
Mietz, August, New York.
Norwalk Iron Wks., Norwalk, Conn.
Wisconsin Engine Co., Corliss, Wis.

Air Brakes.
Westinghouse Air Brake Co., Pittsburg.

Air Drills.
American Compressor & Pump Co., New York.
Helwig Mfg. Co., St. Paul.
Ingersoll-Rand Co., New York.

Air Hoists.
American Compressor & Pump Co., New York.
Brown Hoisting Mchy Co., Cleveland.
Curtis & Co. Mfg. Co., St. Louis.
Ingersoll-Rand Co., New York.
Northern Engineering Works, Detroit.

Air Motors.
Ingersoll-Rand Co., New York.

Air Receivers.
American Compressor & Pump Co., New York.
Graver Tank Wks., Wm., East Chicago, Ind.
Scaife & Sons Co., Wm. B., Pittsburgh.

Air Tube Heaters.
Harrison Eng'g Co., New York.

Air Washers & Humidifiers.
Buffalo Forge Co., Buffalo.
Carrier Air Conditioning Co. of Amer., New York.
Griscom-Spencer Co., New York.
Webster & Co., Warren, Camden, N. J.

Alarms, High and Low.
Wright Mfg. Co., Detroit.

Alcohol Engines.
Foos Gas Engine Co., Springfield, O.

Alternators.
Fort Wayne Electric Works, Fort Wayne, Ind.

Ammeters.
Bristol, Co., Waterbury, Conn.
Western Electric Co., Chicago.
Weston Elec. Inst. Co., Waverly Pk., Newark, N. J.

Anchors, Screw.
Star Expansion Bolt Co., New York.

Anti-Friction Metals.
Allan & Son, A., New York.
Magnolia Metal Co., New York.
Phosphor Bronze Smelting Co., Phila.
Poole Eng. & Mach. Co., Baltimore.

Asphalt.
American Asphaltum & Rubber Co., Chicago.

Automatic Governors for Air Compressors.
Westinghouse Air Brake Co., Pittsburg.

Automatic Grab Buckets.
Hayward Co., New York.
Mead-Morrison Mfg. Co., Boston.
Wellman-Seaver-Morgan Co., Cleveland.

Automatic Weighing Machines.
Richardson Scale Co., New York.

Automobile Drop Forgings.
Chicago Drop Forge & Foundry Co., Kensington, Ill.

Babbitt Metals.
Magnolia Metal Co., New York.

Ballast Unloaders.
Bucyrus Co., Sth. Milwaukee, Wis.
Marion Steam Shovel Co., Marion, O.

Ball Bearings.
American Ball Co., Providence.

Band Saws.
Fay & Egan Co., Cincinnati.

Bearing Metal.
Allan & Son, A., New York.
Magnolia Metal Co., New York.
Phosphor Bronze Smelting Co., Philadelphia.

Belt Conveyors.
Boston Belting Co., Boston.
Caldwell & Son Co., H. W., Chicago.
Dodge Mfg. Co., Mishawaka, Ind.
Jeffrey Mfg. Co., Columbus.
Mead-Morrison Mfg. Co., Boston.
Rhoads & Sons, J. E., Philadelphia.
Robins Conveying Belt Co., N. Y.
Stephens-Adamson Mfg. Co., Aurora, Ill.

Belt Dressing (Waterproof).
Dixon Crucible Co., Jos., Jersey City.

Belting.
Boston Belting Co., Boston.
Eureka Fire Hose Mfg. Co., N. Y.
Jeffrey Mfg. Co., Columbus.
Rhoads & Sons, J. E., Philadelphia.
Simmons Co., Jno., New York.

Belt Dressing.
Rhoads & Sons, J. E., Philadelphia.

Belt Lacing.
Bristol Co., Waterbury, Conn.
Rhoads & Sons, J. E., Philadelphia.
Robins Conveying Belt Co., N. Y.

Bending Rolls.
Niles-Bement-Pond Co., New York.
Sellers Co., Inc., William, Phila.

Blast Furnaces.
Kennedy, Walter, Pittsburg.
McClure, Son & Co., G. W., Pittsburg.
Riter-Conley Mfg. Co., Pittsburg.
Tippett & Wood, Phillipsburg, N. J.

Blowers.
American Blower Co., Detroit.
American Gas Furnace Co., N. Y.
Buffalo Forge Co., Buffalo.
Crocker-Wheeler Co., Ampere, N. J.
Green Fuel Economizer Co., Matteawan, N. Y.
Massachusetts Fan Co., Watertown, Mass.
Parson Mfg. Co., New York.
Sirocco Engng. Co., Detroit, Mich.
Sturtevant Co., B. F., Hyde Park, Mass.
Western Electric Co., Chicago.
Wing Mfg. Co., L. J., New York.

Blowers, Turbine.
Wing Mfg. Co., L. J., New York.

Blue Print Machines.
Williams, Brown & Earle, Inc., Philadelphia.

Boiler Feeders.
Powell Co., Wm., Cincinnati.

Boiler Fronts and Fittings.
Continental Iron Wks., Brooklyn.
McGowan Co., John H., Cincinnati, O.
Powell Co., Wm., Cincinnati.
Simmons Co., John, New York.
Walworth Mfg. Co., Boston.

Boiler Furnace Equipment.
Parson Mfg. Co., New York.

Boiler Inspection and Insurance.
Fidelity & Casualty Co., New York.

Boilers.
Abendroth & Root Mfg. Co., Newburgh, N. Y.
Babcock & Wilcox Co., New York.
Franklin Boiler Wks. Co., New York.
Graver Tank Works, Wm., East Chicago, Ind.
Griscom-Spencer Co., New York.
Harrison Safety Boiler Wks., Phila.
Heine Safety Boiler Co., St. Louis.
Holyoke Steam Boiler Works, Holyoke, Mass.
Kennicott Company, Chicago.
Morris Co., I. P., Philadelphia.
Oil Well Supply Co., Oswego, N. Y.

For Alphabetical Index to Advertisers see page 11.

Petroleum Iron Works Co., Sharon, Pa.
Riter-Conley Mfg. Co., Pittsburg.
Scaife & Sons Co., Wm. B., Pittsburgh.
Smith & Son Co., Sam'l, Paterson, N. J.
Tippett & Wood, Phillipsburg, N. J.
Walsh's Boiler Wks., Holyoke, Mass.

Boiler Settings.

Harbison Walker Refractories Co., Pittsburg, Pa.

Bolt and Nut Machinery.

Niles-Bement-Pond Co., New York.

Bolts, Expansion.

Star Expansion Bolt Co., New York.

Bolts, Toggle.

Star Expansion Bolt Co., New York.

Boosters.

Crocker-Wheeler Co., Ampere, N. J.

Boring Mills.

Niles-Bement-Pond Co., New York.
Sellers Co., William, Inc., Phila.

Brakes (Electric).

Electric Controller & Mfg. Co., Cleveland, O.

Brakes—Friction.

Elec. Controller & Mfg. Co., Cleveland.

Brass Founders' Supplies.

Obermayer Co., S., Cincinnati.

Brass Makers' Lathes.

Am. Tool & Machine Co., Boston.
Niles-Bement-Pond Co., New York.

Brick.

Harbison Walker Refractories Co., Pittsburg, Pa.
Maurer & Son, Henry, New York.

Brick and Tile Machinery.

American Blower Co., Detroit.
Jeffrey Mfg. Co., Columbus.

Bridges, Roofs, etc.

Brown Hoisting Mchy. Co., Cleveland.
Riter-Conley Mfg. Co., Pittsburg.
Scaife & Sons Co., Wm. B., Pittsburg.
Tippett & Wood, Phillipsburg, N. J.
Walsh's Boiler Wks., Holyoke, Mass.
Wellman-Seaver-Morgan Co., Cleveland.

Bronze Bearings.

Allan & Son, A., New York.
Phosphor Bronze Smelting Co., Ltd., Philadelphia.

Bronze Vanadium.

American Vanadium Co., Pittsburg.

Bucket Elevators.

Dodge Mfg. Co., Mishawaka, Ind.
Hayward Co., The, New York.
Jeffrey Mfg. Co., Columbus.
Mead-Morrison Mfg. Co., Boston.
Robins Conveying Belt Co., N. Y.
Stephens-Adamson Mfg. Co., Aurora, Ill.
Webster Mfg. Co., Chicago.

Buckets—Dredging & Excavating.

Bucyrus Co., Sth. Milwaukee, Wis.
Hayward Co., New York.
Wellman-Seaver-Morgan Co., Cleveland.

Buildings, Iron, Steel and Steel Concrete.

Brown Hoisting Mchy. Co., Cleveland.
Riter-Conley Mfg. Co., Pittsburg.
Scaife & Sons Co., Wm. B., Pittsburgh.

Bulldozers.

Niles-Bement-Pond Co., New York.
Wood & Co., R. D., Phila., Pa.

Cable-Railway Machinery.

Mead-Morrison Mfg. Co., Boston.
Poole Eng'g & Mch. Co., Baltimore.
Robins Conveying Belt Co., N. Y.

Cables, Elec. & Submarine.

General Electric Co., New York.
Western Electric Co., Chicago.

Cableways—

(See Aerial Tramways.)

Cables, Wire.

Lidgerwood Mfg. Co., New York.
Phosphor Bronze Smelting Co., Ltd., Philadelphia.

Carbide of Silicon.

Carborundum Co., Niagara Falls, N.Y.

Carborundum.

Carborundum Co., Niagara Falls, N.Y.

Carborundum Paper & Cloth.

Carborundum Co., Niagara Falls, N.Y.

Cars.

Mead-Morrison Mfg. Co., Boston.
Wellman-Seaver-Morgan Co., Cleveland.

Car Dumpers.

Wellman-Seaver-Morgan Co., Cleveland.

Car Shop Machinery.

Fay & Egan Co., Cincinnati.
Niles-Bement-Pond Co., New York.
Pratt & Whitney Co., Hartford.
Wood & Co., R. D., Phila., Pa.

Castings, Brass, Bronze & Composition.

Allan & Son, A., New York.
D'Este Co., Julian, Boston.
Morris Co., I. P., Philadelphia.
Phosphor Bronze Smelting Co., Phila.

Castings, Iron & Steel.

Bruce-Macbeth Engine Co., Cleveland.
Caldwell & Son Co., H. W. Chicago.
Chester Steel Castings Co., Philadelphia.
Curtis & Co. Mfg. Co., St. Louis.
Flagg & Co., Stanley G., Phila.
Fox & Co., Jno., New York.
Hooven Owens-Rentschler Co., Hamilton, O.
Jeffrey Mfg. Co., Columbus.
Morris Co., I. P., Philadelphia.
Phosphor Bronze Smelting Co., Ltd., Philadelphia.
Poole Eng'g & Mch. Co., Baltimore.
Powell Co., Wm., Cincinnati.
Riter-Conley Mfg. Co., Pittsburg.
Simmons Co., John, New York.
U. S. Cast Iron Pipe & Fdy. Co., New York.
Walworth Mfg. Co., Boston.
Wellman-Seaver-Morgan Co., Cleveland.
Wood & Co., R. D., Phila., Pa.

Castings, Monel Metal.

Bayonne Casting Co., Bayonne, N. J.

Cast-Iron Pipe.

Fox & Co., John, New York.
U. S. Cast Iron Pipe & Fdy. Co., New York.
Walworth Mfg. Co., Boston.
Wood & Co., R. D., Phila., Pa.

Cement, Iron.

Obermayer Co., S., Cincinnati.

Cement Machinery.

Bradley Pulverizer Co., Boston.
Caldwell & Sons Co., H. W., Chicago.
Dunning, W. D., Syracuse, N. Y.
Jeffrey Mfg. Co., Columbus.
Mead-Morrison Mfg. Co., Boston.
Robins Conveying Belt Co., N. Y.
Ruggles-Coles Eng'g Co., New York.

Cement, Portland.

Alsen's Am. Portland Cement Co., New York.
American Cement Co., Phila.
Atlas Portland Cement Co., N. Y.
Glens Falls Portland Cement Co., Glens Falls, N. Y.
Lehigh Portland Cement Co., Allentown, Pa.

Chains.

Diamond Chain & Mfg. Co., Indianapolis.
Morse Chain Co., Ithaca, N. Y.

Chain Belting.

Caldwell & Sons Co., H. W., Chicago.
Jeffrey Mfg. Co., Columbus.
Morse Chain Co., Ithaca, N. Y.
Stephens-Adamson Mfg. Co., Aurora, Ill.

Chain Joint.

Morse Chain Co., Ithaca, N. Y.

Chain Pipe & Fittings Wrenches.

Walworth Mfg. Co., Boston.

Channeling Machines.

Ingersoll-Rand Co., New York.

Checks, Time, Pay & Trade.

Schwerdtle Stamp Co., Bridgeport.

Chucks.

Almond Mfg. Co., Ashburnham, Mass.
American Tool & Mach. Co., Boston.
Niles Bement-Pond Co., New York.

Circuit Breakers.

Electric Controller & Mfg. Co., Cleveland, O.

Clamps, Cable.

Star Expansion Bolt Co., New York.

Clocks.

Industrial Instrument Co., Foxboro, Mass.

Clutches, Magnetic.

Elec. Controller & Mfg. Co., Cleveland.

Clutch Pulleys.

American Pulley Co., Philadelphia.
Caldwell & Sons Co., H. W., Chicago.
Philips Pressed Steel Pulley Wks., Philadelphia.
Stephens-Adamson Mfg. Co., Aurora, Ill.
Wellman-Seaver-Morgan Co., Cleveland.

Coal- and Ash-Handling Machinery.

Brown Hoisting Mchy. Co., Cleveland.
Caldwell & Sons Co., H. W., Chicago.
Dodge Mfg. Co., Mishawaka, Ind.
Exeter Machine Wks., Pittston, Pa.
Hayward Co., New York.
Jeffrey Mfg. Co., Columbus.
Lidgerwood Mfg. Co., New York.

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Mead-Morrison Mfg. Co., Boston.
Robins Conveying Belt Co., N. Y.
Stephens-Adamson Mfg. Co., Aurora, Ill.
Wellman-Seaver-Morgan Co., Cleveland.

Coal Cutters (Air and Electric).

Igersoll-Rand Co., New York.
Jeffrey Mfg. Co., Columbus.

Coal and Ore Bunkers.

Morris Co., I. P., Philadelphia.

Coal-Mining Machinery.

Exeter Machine Works, Pittston, Pa.
General Electric Co., New York.
Ingersoll-Rand Co., New York.
Jeffrey Mfg. Co., Columbus.
Lambert Hoist. Engine Co., Newark
McGowan Co., John H., Cincinnati.
Norwalk Iron Wks., So. Norwalk, Ct.
Robins Conveying Belt Co., Passaic, N. J.
Stephens-Adamson Mfg. Co., Aurora, Ill.
Vulcan Iron Works, Wilkes-Barre, Pa.
Wellman-Seaver-Morgan Co., Cleveland.
Westinghouse Elec. & Mfg. Co., Pittsburg.

Coal Screens.

Jeffrey Mfg. Co., Columbus.
Jerguson Mfg Co., Boston.
Ludlow-Saylor Wire Co., St. Louis.
Mead-Morrison Mfg. Co., Boston.
Robins Conveying Belt Co., N. Y.
Stephens-Adamson Mfg. Co., Aurora, Ill.

Cocks.

Powell Co., Wm., Cincinnati.
Simmons Co., Jno., New York.
Walworth Mfg. Co., Boston.
Wright Mfg. Co., Detroit.

Coil Pipe.

National Pipe Bending Co., New Haven.
Simmons Co., Jno., New York.

Coke-Oven Machinery.

Wellman-Seaver-Morgan Co., Cleveland.

Concrete Mixers.

Dunning, W. D., Syracuse, N. Y.
Jeffrey Mfg. Co., Columbus.

Concrete Piles.

Simmons Co., John, New York.

Concrete Reinforcing.

American Steel & Wire Co., Chicago.

Condensers.

Alberger Condenser Co., New York.
McGowan Co., John H., Cincinnati.
Wheeler Condenser & Eng'g Co., N.Y.

Continuous Elevators.

Caldwell & Son Co., H. W., Chicago.
Stephens-Adamson Mfg. Co., Aurora, Ill.

Contractors, General.

White & Co., J. G., New York.

Controllers, Electric.

Elec. Controller & Mfg. Co., Cleveland.

Conveying Machinery.

Brown Hoisting Mchy. Co., Cleveland.
Caldwell & Sons Co., H. W. Chicago.
Dodge Mfg. Co., Mishawaka, Ind.
Exeter Machine Wks., Pittston, Pa.
Hayward Co., The, New York.
Jeffrey Mfg. Co., Columbus.
Lidgerwood Mfg. Co., New York.
Maris Bros., Philadelphia.
Mead-Morrison Mfg. Co., Boston.
Robins Conveying Belt Co., Passaic, N. J.
Stephens-Adamson Mfg. Co., Aurora, Ill.
Sturtevant Co., B. F., Hyde Park, Mass.
Wellman-Seaver-Morgan Co., Cleveland.

Cooling Towers.

De La Vergne Mach. Co., New York.
Stocker, George J., St. Louis.
Wheeler Condenser & Eng'g Co., Carteret, N. J.

Copper Gaskets.

Simmons Co., Jno., New York.

Cordage.

American Mfg. Co., New York.

Core Compound.

Obermayer Co., S., Cincinnati.

Cork Inserts.

National Brake & Clutch Co., Boston.

Corliss Engines.

Wisconsin Engine Co., Corliss, Wis.
Hooven-Owens-Rentschler Co., Hamilton, O.
Wellman-Seaver-Morgan Co., Cleveland.

Cost Systems.

Cooper & Co., John Alex. Chicago, Ill.

Couplings.

Almond Mfg. Co., Ashburnham, Mass.
Caldwell & Son Co., H. W., Chicago.
Dodge Mfg. Co., Mishawaka, Ind.
Sellers & Co., Inc., Wm., Phila.
Stephens-Adamson Mfg. Co., Aurora, Ill.
Walworth Mfg. Co., Boston.

Couplings, Flexible.

Electric Controller & Mfg. Co., Cleveland, O.

Cranes.

Brown Hoisting Machy. Co., Cleveland.
Curtis & Co. Mfg. Co., St. Louis.
Hayward Co., The New York.
Industrial Works, Bay City, Mich.
Maris Bros., Philadelphia.
Niles-Bement-Pond Co., New York.
Obermayer Co., S., Cincinnati.
Northern Engineering Works, Detroit, Mich.
Riter-Conley Mfg. Co., Pittsburg.
Sellers & Co., Inc., Wm., Phila.
Shepard Electric Crane & Hoist Co., Montour Falls, New York.
Wellman-Seaver-Morgan Co., Cleveland.
Wood & Co., R. D., Phila.

Crane Motors.

Western Electric Co., Chicago.

Crucibles.

Dixon Crucible Co., Jos., Jersey City.
Obermayer Co., S., Cincinnati.

Crushers, Ore, Phosphate, Rock.

Jeffrey Mfg. Co., Columbus.

Cupolas.

Obermayer Co., S., Cincinnati.
Northern Engineering Works, Detroit.
Riter-Conley Mfg. Co., Pittsburg.

Cupro Vanadium.

American Vanadium Co., Pittsburg.

Cutters, Milling.

Pratt & Whitney Co., Hartford.

Cylinders.

Graver Tank Wks., Wm., East Chicago, Ind.
U. S. Cast Iron Pipe & Fdy. Co., New York.

Damper Regulator.

D'Este Co., Julian, Boston.
Kitts Manufacturing Co., Oswego, N. Y.

Derricks and Fittings.

Brown Hoisting Mchy. Co., Cleveland.
Lidgerwood Mfg. Co., New York.
Northern Engineering Works, Detroit.

Digesters.

Holyoke Steam Boiler Works, Holyoke, Mass.
Riter-Conley Mfg. Co., Pittsburg.
Tippett & Wood, Phillipsburg, N. J.

Ditching Machinery.

Austin Drainage Excavator Co., Chicago.

Doors, Hollow Metal.

Dahlstrom Metallic Door Co., Jamestown, N. Y.

Draft, Mechanical.

American Blower Co., Detroit.
Buffalo Forge Co., Buffalo.
Green Fuel Economizer Co., Matteawan, N. Y.
Massachusetts Fan Co., Watertown, Mass.
Sturtevant Co., B. F., Hyde Park, Mass.
Wing Mfg. Co., L. J., New York.

Drafting Room Equipment.

Buff & Buff Mfg. Co., Boston.

Drilling Machines.

American Tool Wks. Co., Cincinnati, Ohio.
Ingersoll-Rand Co., New York.
Niles-Bement-Pond Co., New York.
Pratt & Whitney Co., Hartford.
Sellers Co., Inc., William, Phila.
Stow Mfg. Co., Binghamton, N. Y.

Drills, Brick and Stone.

Star Expansion Bolt Co., New York.

Drills, Diamond Core.

Ingersoll-Rand Co., New York.

Drills, Extension.

Star Expansion Bolt Co., New York.

Drills, Holders.

Star Expansion Bolt Co., New York.

Drills, Pipe and Star.

Star Expansion Bolt Co., New York.

Drills, Rail.

Niles-Bement-Pond Co., New York.

Drills—Rock and Coal.

Ingersoll-Rand Co., New York.
Jeffrey Mfg. Co., Columbus.

Drop Forgings.

Chicago Drop Forge & Fdy. Co., Kensington, Ill.
Phosphor Bronze Smelting Co., Ltd., Philadelphia.
Wyman & Gordon Co., Worcester, Mass.

Dryers.

Ruggles-Coles Engng. Co., New York.

Drying Apparatus.

American Blower Co., Detroit.
Buffalo Forge Co., Buffalo.
Green Fuel Economizer Co., Matteawan, N. Y.
Sirocco Engng. Co., Detroit, Mich.
Sturtevant Co., B. F., Hyde Park, Mass.

Dumps, Automatic.

Jeffrey Mfg. Co., Columbus.

Dynamite.

Du Pont De Nemours Powder Co., E. I., Wilmington, Dela.
Keystone National Powder Co., Emporium, Pa.
National Powder Co., Emporium, Pa.
Sinnamahoning Powder Co., Emporium, Pa.

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Dynamometers.
Sprague Electric Co., New York.

Dynamos.
Crocker-Wheeler Co., Ampere, N. J.
Fort Wayne Electric Wks., Fort Wayne, Ind.
Garwood Electric Co., Garwood, N. J.
General Electric Co., New York.
Jeffrey Mfg. Co., Columbus.
Northern Elec. Mfg. Co., Madison.
Ridgway Dynamo & Engine Co., Ridgway, Pa.
Sprague Electric Co., New York.
Sturtevant Co., B. F., Hyde Park, Mass.
Western Electric Co., Chicago.
Westinghouse Elec. & Mfg. Co., Pittsburg.

Ejectors.
Watson & McDaniel Co., Philadelphia.

Elbows, Pipe.
Walworth Mfg. Co., Boston.

Electric Bells.
Western Electric Co., Chicago.

Electric Fault Finders.
Electric Controller & Mfg. Co., Cleveland, O.

Electric Heating Apparatus.
Simplex Elec. Heating Co., Cambridgeport, Mass.

Electric Hoists.
Brown Hoisting Mchy. Co., Cleveland.
Exeter Machine Works, Pittston, Pa.
Lambert Hoist Eng. Co., Newark.
Lidgerwood Mfg. Co., New York.
Mead-Morrison Mfg. Co., Boston.
Niles-Bement-Pond Co., New York.
Northern Engineering Works, Detroit.
Shepard Electric Crane & Hoist Co., Montour Falls, N. Y.
Sprague Electric Co., New York.
Vulcan Iron Works, Wilkes-Barre, Pa.
Wellman-Seaver-Morgan Co., Cleveland.
Western Electric Co., Chicago.

Elec. Light & Power Plants.
De La Vergne Mach Co., New York.
Foos Gas Engine Co., Springfield, O.
Mietz Iron Fdy. & Mach. Wks., August, New York.

Electrical Furnaces.
Engelhard, Charles, New York.

Elec. Measuring Instruments.
Bristol Co., Waterbury, Conn.
Weston Elec. Instrument Co., Waverly Park, Newark, N. J.

Elec. Welding Outfits.
Garwood Electric Co., Garwood, N. J.
Mfrs. Supply House, Erie, Pa.

Elevating and Conveying
Caldwell & Son Co., H. W., Chicago.
Dodge Mfg. Co., Mishawaka, Ind.
Exeter Machine Wks., Pittston, Pa.
Industrial Wks., Bay City, Mich.
Jeffrey Mfg. Co., Columbus.
Lidgerwood Mfg. Co., New York.
Maris Bros., Philadelphia.
Northern Engineering Works, Detroit.
Robins Conveying Belt Co., Passaic, N. J.
Stephens-Adamson Mfg. Co., Aurora, Ill.
Webster Mfg. Co., Chicago.

Elevator Insurance.
Fidelity & Casualty Co., New York.

Elevator, Portable.
New York Revolving Portable Elevator Co., Jersey City.

Elevators.
Caldwell & Son Co., H. W., Chicago.
Curtis & Co. Mfg. Co., St. Louis.
Dodge Mfg. Co., Mishawaka, Ind.
Jeffrey Mfg. Co., Columbus.
Mead-Morrison Mfg. Co., Boston.
Obermayer Co., S., Cincinnati.
Poole Eng'g Mch. Co., Baltimore.
Stephens-Adamson Mfg. Co., Aurora, Ill.

Employers' Liability Insurance.
Fidelity & Casualty Co., New York.

Engineering Instruments.
Altenedер & Sons, Theo., Phila.
Brandis Sons Co., Brooklyn.
Bristol Co., Waterbury, Conn.
Buff & Buff Mfg. Co., Boston.
Queen & Co., Philadelphia.

Engineering Specialties.
D'Este Co., Julian, Boston.
Industrial Inst. Co., Foxboro, Mass.
Industrial Supply & Equipment Co., Philadelphia.
Powell Co., Wm., Cincinnati.

Engineers.
Arnold Co., Chicago.
Barnaby, Charles W., New York.
Baum & Co., Frank G., San Francisco.
Brill & Gardiner, Chicago.
Byllesby & Co., H. M., Chicago.
Christie, W. Wallace, Paterson, N. J.
Dodge & Day, Philadelphia.
Harrison Eng'g Co., New York.
Kennedy, Julian, Pittsburg.
Kennedy, Walter, Pittsburg.
McClure, Son & Co., G. W., Pittsburg.
Moses, P. R., New York.
Porter, H. F. J., New York.
Robinson, A. W., Montreal, Canada.
Roetker, H. B., New York.
Stone & Webster Eng'g Corp., Boston.
Tait Producer Co., New York.
Thomson, T. Kennard, New York.
Universal Audit Company, New York.
Wellman-Seaver-Morgan Co., Cleveland.
White & Co., J. G., New York.

Engines—Blowing.
Bruce-Macbeth Engine Co., Ohio.
Wellman-Seaver-Morgan Co., Cleveland.
Wisconsin Engine Co., Corliss, Wis.

Engines, Gas & Gasoline.
(See Gas and Gasoline Engines).

Engines, Marine.
De La Vergne Mach Co., New York.
Mietz, August, New York.

Engines, Steam.
American Blower Co., Detroit.
American Engine Co., Bound Brook, N. J.
Ball Engine Co., Erie, Pa.
Brown Hoisting Mchy. Co., Cleveland.
Buffalo Forge Co., Buffalo.
Harrisburg Fdy. & Mch. Wks., Harrisburg, Pa.
Hooven-Owens-Rentschler Co., Hamilton, O.
Ridgway Dynamo & Engine Co., Ridgway, Pa.
Skinner Engine Co., Erie, Pa.
Sturtevant Co., B. F., Hyde Park, Mass.
Trenton Engine Co., Trenton, N. J.
Wellman-Seaver-Morgan Co., Cleveland.
Westinghouse, Church, Kerr & Co., New York.
Westinghouse Mch. Co., Pittsburg.
Wisconsin Engine Co., Corliss, Wis.

Evaporators.
Wheeler Condenser & Eng'g. Co., Carteret, N. J.

Excavators.
Austin Drainage Excavator Co., Chicago.
Bucyrus Co., 5th. Milwaukee, Wis.
Hayward Co., The, New York.
Jeffrey Mfg. Co., Columbus.
Lidgerwood Mfg. Co., New York.
Marion Steam Shovel Co., Marion, O.
Robins Conveying Belt Co., Passaic, N. J.

Exhaust Heads.
Abendroth & Root Mfg. Co., Newburgh, N. Y.
Direct Separator Co., Syracuse.
Hoppes Mfg. Co., Springfield, Ohio.
Industrial Inst. Co., Foxboro, Mass.
McGowan Co., John H., Cincinnati, O.
Sturtevant Co., B. F., Hyde Park, Mass.
Watson & McDaniel Co., Phila.
Williams, Franklin, New York.
Wright Mfg. Co., Detroit.

Exhaust Heads (Cast Iron).
Hoppes Mfg. Co., Springfield, O.

Explosives.
Du Pont-De Nemours Powder Co., E. I., Wilmington, Del.
Keystone National Powder Co., Emporium, Pa.
National Powder Co., Emporium, Pa.
Sinnamahoning Powder Co., Emporium, Pa.

Fans, Electric.
Sprague Electric Co., New York.
Western Electric Co., Chicago.
Wing Mfg. Co., L. J., New York.

Fans, Ventilating.
American Blower Co., Detroit.
Buffalo Forge Co., Buffalo.
Green Fuel Economizer Co., Mattenwan, N. Y.
Massachusetts Fan Co., Watertown, Mass.
Power Specialty Co., New York.
Sirocco Engng. Co., Detroit, Mich.
Sturtevant Co., B. F., Hyde Park, Mass.
Western Electric Co., Chicago.
Wing Mfg. Co., L. J., New York.

Feed Water Filters.
Ross Valve Mfg. Co., Troy, N. Y.

Feed Water Heaters and Purifiers.
Alberger Condenser Co., New York.
Booth Co., L. M., New York.
Dodge Mfg. Co., Mishawaka, Ind.
Green Fuel Economizer Co., Mattenwan, N. Y.
Griscom-Spencer Co., New York.
Harrison Safety Boiler Wks., Phila.
Hoppes Mfg. Co., Springfield, O.
McGowan Co., John H., Cincinnati.
National Pipe Bending Co., New Haven.
Petroleum Iron Wks. Co., Sharon, Pa.
Ross Valve Mfg. Co., Troy.
Scaife & Sons Co., Wm. B., Pittsburg.
Stewart Heater Co., Buffalo, N. Y.
Webster & Co., Warren, Camden, N. J.
Wheeler Condenser & Eng'g Co., Carteret, N. J.

Feed Water Regulators.
Kitts Mfg. Co., Oswego, N. Y.
Williams Gauge Co., Pittsburgh, Pa.

Felt Roofing.
Barrett Mfg. Co., New York.

Fences.
Anchor Post Iron Works, New York.

Fence Posts.
Anchor Post Iron Works, New York.

Ferro Vanadium.
American Vanadium Co., Pittsburg.

Fibre Rods, Tubes, Washers, etc.
Diamond State Fibre Co., Elsmere, Del.

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Files and Rasps.

Barnett Co., G. & H., Phila.
Carver File Works, Philadelphia.
Nicholson File Co., Providence.

Filter Presses.

Am. Tool & Machine Co., Boston.
Niles-Bement-Pond Co., New York.

Filters.

Booth Co., L. M., New York.
Ross Valve Mfg. Co., Troy.
Scaife & Sons Co., Wm. B., Pittsburg.

Filters, Oil.

Industrial Inst. Co., Foxboro, Mass.
Wright Mfg. Co., Detroit.

Fire Brick

Harbison Walker Refractories Co., Pittsburg, Pa.
Maurer & Son, Henry, New York.
Obermayer Co., S., Cincinnati.

Fire Clay.

Carborundum Co., Niagara Falls, N. Y.
Harbison Walker Refractories Co., Pittsburg, Pa.
Obermayer Co., S., Cincinnati.

Fire Door Equipment.

Dahlstrom Metallic Door Co., Jamestown, N. Y
Kinnear Mfg. Co., Columbus, O.

Fire Hose.

Boston Belting Co., Boston.
Eureka Fire Hose Mfg. Co., New York.
Simmons Co., John, New York.

Fireproof Building Materials.

Maurer & Son, Henry, New York.

Fittings.

Simmons Co., Jno., New York.
Walworth Mfg. Co., Boston.

Fittings, Ammonia.

De La Vergne Mach. Co., New York.

Fittings, Electric Crane.

Electric Controller & Mfg. Co., Cleveland, O.

Flanges.

McGowan Co., John H., Cincinnati, O.
Walworth Mfg. Co., Boston.

Flexible Shafts.

Stow Mfg. Co., Binghamton, N. Y.

Flexible Steel Tubing.

Almond Mfg. Co., Ashburnham, Mass.

Floor and Sidewalk Lights.

Brooks & Co., T. H., Cleveland.

Fly Wheels.

Bruce-Macbeth Engine Co., Cleveland, O.
Dodge Mfg. Co., Mishawaka, Ind.
Poole Eng'g & Mch. Co., Baltimore.
Wellman-Seaver-Morgan Co., Cleveland.

Forges.

Buffalo Forge Co., Buffalo.
Ingersoll-Rand Co., New York.
Sturtevant Co., B. F., Hyde Park, Mass.

Forgings, Iron and Steel.

Bruce-Macbeth Engine Co., Cleveland, O.
Chicago Drop Forge & Fdy. Co., Kensington, Ill.
Phosphor Bronze Smelting Co., Ltd., Philadelphia.
Wyman & Gordon, Worcester.

Forgings, Monel Metal.

Bayonne Casting Co., Bayonne, N. J.

Forgings, Vanadium.

American Vanadium Co., Pittsburg.

Foundry Equipment.

American Blower Co., Detroit.
Ingersoll-Rand Co., New York.
Northern Engineering Works, Detroit.
Obermayer Co., S., Cincinnati.

Foundry Riddles.

Obermayer Co., S., Cincinnati.

Foundry Supplies.

Ingersoll-Rand Co., New York.
Obermayer Co., S., Cincinnati.

Friction Clutches.

American Pulley Co., Philadelphia.
Am. Tool & Mch. Co., Boston.
Caldwell & Son Co., H. W., Chicago.
Poole Eng'g & Mch. Co., Baltimore.
Pyott Co., Chicago.
Stephens-Adamson Mfg. Co., Aurora, Ill.
Wellman-Seaver-Morgan Co., Cleveland.

Fuel Economizers.

Green Fuel Economizer Co., Matteawan, N. Y.
Parson Mfg. Co., New York.
Sturtevant Co., B. F., Hyde Park, Mass.

Furnace Builders.

Am. Gas Furnace Co., New York.
Continental Iron Works, Brooklyn.
Kennedy, Julian, Pittsburg.
McClure, Son & Co., G. W., Pittsburg.
Morgan Const. Co., Worcester.
Riter-Conley Mfg. Co., Pittsburg.
Tait Producer Co., New York.
Tippett & Wood, Phillipsburg, N. J.
Wellman Seaver-Morgan Co., Cleveland.

Fused Silica Wire.

Engelhard, Charles, New York.

Gages—Pressure, Steam, Water.

Bristol Co., Waterbury, Conn.
Industrial Inst. Co., Foxboro, Mass.
Powell Co., Wm., Cincinnati.
Schaeffer & Budenberg Mfg. Co., Brooklyn.
Walworth Mfg. Co., Boston.
Wright Mfg. Co., Detroit.

Galvanized Sheet Steel.

Inland Steel Co., Chicago.

Galvanometers.

Weston Elec. Instrument Co., Waverly Park, Newark, N. J.

Gas Blowers & Exhausters.

American Blower Co., Detroit.
Buffalo Forge Co., Buffalo.
Sturtevant Co., B. F., Hyde Park, Mass.

Gas Engine Indicators.

Schaeffer & Budenberg Mfg. Co., Brooklyn.

Gas & Gasoline Engines.

Bruce-Macbeth Engine Co., Cleveland, O.
Buckeye Engine Co., Salem, Ohio.
Clark & Norton Mfg. Co., Wellsville, N. Y.
De La Vergne Machine Co., N. Y.
Foos Gas Engine Co., Springfield, O.
Hooven-Owens-Rentschler Co., Hamilton, O.
Mietz, August, New York.
Turner Fricke Mfg. Co., Pittsburg, Pa.
Westinghouse Mch. Co., Pittsburg.
Westinghouse, Church, Kerr & Co., New York.
Wisconsin Engine Co., Corliss, Wis.

Gas Machines & Generators.

Am. Gas Furnace Co., New York.
Morgan Const. Co., Worcester.
Tait Producer Co., New York.
Wood & Co., R. D., Phila., Pa.

Gas Producers.

Bruce-Macbeth Engine Co., Cleveland, O.
De La Vergne Machine Co., New York.
Foos Gas Engine Co., Springfield, O.
Morgan Construction Co., Worcester.
Power & Mining Mchy. Co., Milwaukee.
Tait Producer Co., New York.
Wellman-Seaver-Morgan Co., Cleveland.
Westinghouse Machine Co., Pittsburg.
Wood & Co., R. D., Phila., Pa.

Gaskets.

Boston Belting Co., Boston.

Gear Cutting Machines.

Gleason Works, Rochester, N. Y.
Pratt & Whitney Co., Hartford.

Gearing.

Bilgram Machine Wks., Philadelphia.
Caldwell & Son Co., H. W., Chicago.
Dodge Mfg. Co., Mishawaka, Ind.
Gleason Works, Rochester, N. Y.
Jeffrey Mfg. Co., Columbus.
New Process Rawhide Co., Syracuse.
Nuttall Co., R. D., Pittsburg.
Poole Eng'g & Mch. Co., Baltimore.
Sellers Co., Inc., Wm., Phila.
Shepard Electric Crane & Hoist Co., Montour Falls, N. Y.
Stephens-Adamson Mfg. Co., Aurora, Ill.

Gears, Vanadium.

American Vanadium Co., Pittsburg.

Generating Sets.

American Blower Co., Detroit.
American Engine Co., Bound Brook, N. J.
Buffalo Forge Co., Buffalo.
Crocker-Wheeler Co., Ampere, N. J.
De La Vergne Machine Co., New York.
Mietz, August, New York.
Ridgway Dynamo & Engine Co., Ridgway, Pa.
Sturtevant Co., B. F., Hyde Park, Mass.

Gold Dredging Machinery.

Bucyrus Co., 8th. Milwaukee, Wis.
Marion Steam Shovel Co., Marion, Ohio.
Wellman-Seaver-Morgan Co., Cleveland.

Graphite.

Dixon Crucible Co., Jos., Jersey City.
Obermayer Co., S., Cincinnati.

Grate Bars.

Bruce-Macbeth Engine Co., Cleveland, O.

Grinding Machinery.

Dodge Mfg. Co., Mishawaka, Ind.

Grinding & Polishing Mchy.

Crocker-Wheeler Co., Ampere, N. J.
Helwig Mfg. Co., St. Paul.
Landis Tool Co., Waynesboro, Pa.
Stow Mfg. Co., Binghamton, N. Y.

Grinding & Pulverizing Mchy

Bradley Pulverizer Co., Boston.
Dunning, W. D., Syracuse.
Wellman-Seaver-Morgan Co., Cleveland.

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Grinding Wheels.
Carborundum Co., Niagara Falls, N. Y.

Grinding Wheels (Alundum).
Norton Co., Worcester, Mass.

Hack Saws.
Niles-Bement-Pond Co., New York.

Hammers, Electric.
Helwig Mfg. Co., St. Paul.

Heating Furnaces.
Wellman-Seaver-Morgan Co., Cleveland.

Heating and Ventilating Apparatus.
American Blower Co., Detroit.
Buffalo Forge Co., Buffalo.
Green Fuel Economizer Co., Matteawan, N. Y.
Harrison Eng'g Co., New York.
Hitchings & Co., New York.
Lord & Burnham Co., Irvington-on-Hudson, N. Y.
Simmons Co., John, New York.
Sturtevant Co., B. F., Hyde Park, Mass.
Walworth Mfg. Co., Boston.
Wing Mfg. Co., L. J., New York.

Hoisting Engines and Mchy.
Brown Hoisting Mchy. Co., Cleveland.
Bruce-Macbeth Engine Co., Ohio.
Exeter Machine Wks., Pittston, Pa.
Flory Mfg. Co., S., Bangor, Pa.
Foos Gas Engine Co., Springfield, O.
Hayward Co., New York.
Industrial Works, Bay City, Mich.
Jeffrey Mfg. Co., Columbus.
Lambert Hoist. Eng. Co., Newark.
Lidgerwood Mfg. Co., New York.
Mead-Morrison Mfg. Co., Boston.
Mietz, August, New York.
Northern Engineering Works, Detroit.
Robins Conveying Belt Co., Passaic, N. J.
Sellers Co., Wm., Inc., Philadelphia.
Shepard Electric Crane & Hoist Co., Montour Falls, New York.
Vulcan Iron Works, Wilkes-Barre, Pa.
Wellman-Seaver-Morgan Co., Cleveland.
Wisconsin Engine Co., Corliss, Wis.

Hoisting Rope.
American Mfg. Co., New York.

Hose.
Boston Belting Co., Boston.
Eureka Fire Hose Mfg. Co., N. Y.
Simmons Co., John, New York.

Hydraulic Fittings.
McGowan Co., John H., Cincinnati, O.
Simmons Co., Jno., New York.
Walworth Mfg. Co., Boston.

Hydraulic Gauges.
Bristol Co., Waterbury, Conn.
Industrial Inst. Co., Foxboro, Mass.
Schaeffer & Budenberg Mfg. Co., Brooklyn, N. Y.

Hydraulic Leather.
Rhoads & Sons, J. E., Philadelphia.

Hydraulic Machinery.
Goulds Mfg. Co., Seneca Falls, N. Y.
McGowan Co., John H., Cincinnati, O.
Niles-Bement-Pond Co., New York.
Rife Engine Co., New York.
Watson-Stillman Co., New York.
Wood & Co., R. D., Phila., Pa.

Hydraulic Presses.
McGowan Co., John H., Cincinnati, O.
Niles-Bement-Pond Co., New York.
Wood & Co., R. D., Phila., Pa.

Hydraulic Rams.
Pelton Water Wheel Co., San Francisco.
Power Specialty Co., New York.
Rife Engine Co., New York.

Hydraulic Turbines.
Leffel & Co., James, Springfield, Ohio.
Morgan Smith Co., S., York, Pa.
Morris Co., I. P., Philadelphia.
Munson Bros. Co., Utica, N. Y.
Wellman-Seaver-Morgan Co., Cleveland, Ohio.

Ice-Mak'g & Refriger. Mchy.
De La Vergne Machine Co., N. Y.
Roelker, H. B., New York.

India Oil Stones.
Norton Co., Worcester, Mass.

Indicators.
Detroit Lubricator Co., Detroit.
Industrial Inst. Co., Foxboro, Mass.
Schaeffer & Budenberg Mfg. Co., Brooklyn.

Industrial Railways.
Hunt Co., C. W., New York.
Stephens-Adamson Mfg. Co., Aurora, Ill.

Ingots.
Allan & Son, A., New York.
Phosphor Bronze Smelting Co., Ltd., Philadelphia.

Injectors.
Detroit Lubricator Co., Detroit.
Powell Co., Wm., Cincinnati.
Sellers & Co., Inc., Wm., Philadelphia.

Insulation, Electric.
Diamond State Fibre Co., Elsmere, Del.

Insurance.
Fidelity & Casualty Co., New York.

Internal Gearing.
Nuttall Co., R. D., Pittsburg.

Iron & Steel Tubular Poles.
Electric Railway Equipment Co., Cincinnati.
Simmons Co., John, New York.

Jacks, Hydraulic.
Watson-Stillman Co., New York.

Keyseaters.
Niles-Bement-Pond Co., New York.

Keyseat Milling Machine.
Niles-Bement-Pond Co., New York.

Lace Leather.
Rhoads & Sons, J. E., Philadelphia.

Lamps, Electric.
Adams-Bagnall Electric Co., Cleveland.
Cooper-Hewitt Electric Co., New York.
General Electric Co., New York.
Westinghouse Elec. & Mfg. Co., Pittsburg.

Lathes.
Am. Tool & Mch. Co., Boston.
Jones & Lamson Mch. Co., Springfield, Vt.
Niles-Bement-Pond Co., New York.
Pratt & Whitney Co., Hartford.
Sellers Co., Wm., Inc., Philadelphia.

Leather Packing.
Detroit Leather Specialty Co., Inc., Detroit, Mich.
Rhoads & Sons, J. E., Philadelphia.

Lifting Magnets.
Elec. Controller & Mfg. Co., Cleveland.

Light Railways.
Robins Conveying Belt Co., Passaic, N. J.

Lights, Floor & Sidewalk.
Brooks & Co., T. H., Cleveland.

Line Materials, Electric.
Electric Railway Equipment Co., Cincinnati.

Locomotive Cranes.
Brown Hoisting Mchy. Co., Cleveland.
Exeter Machine Wks., Pittston, Pa.
Industrial Works, Bay City, Mich.
Mead-Morrison Mfg. Co., Boston.
Northern Engineering Works, Detroit.
Wellman-Seaver-Morgan Co., Cleveland.

Locomotives.
Baldwin Locomotive Works, Phila.
General Electric Co., New York.
Jeffrey Mfg. Co., Columbus.
Vulcan Iron Works, Wilkes-Barre, Pa.
Westinghouse Elec. & Mfg. Co., Pittsburg.

Logging Machinery.
Lidgerwood Mfg. Co., New York.

Low Water Indicators.
Detroit Lubricator Co., Detroit.

Lubricants.
Dixon Crucible Co., Jos., Jersey City.
Obermayer Co., S., Cincinnati.
Powell Co., Wm., Cincinnati.

Lubricators.
Detroit Lubricator Co., Detroit.
Powell Co., Wm., Cincinnati.

Machinery, Second Hand.
Niles-Bement-Pond Co., New York.

Machinists' Small Tools.
Pratt & Whitney Co., Hartford.

Magnesia Brick Cement.
Harbison Walker Refractories Co., Pittsburg, Pa.

Magnesite.
Harbison Walker Refractories Co., Pittsburg, Pa.

Malleable Castings.
Jeffrey Mfg. Co., Columbus, O.

Manganese Steel.
Taylor Iron & Steel Co., High Bridge, N. J.

Marine Boilers.
Morris Co., I. P., Philadelphia.

Metal Sheets.
Bayonne Casting Co., Bayonne, N. J.

Meters, Electric.
General Electric Co., New York.
Western Electric Co., Chicago.
Westinghouse Elec. & Mfg. Co., Pittsburg.
Weston Elec. Inst. Co., Waverly Park, Newark, N. J.

Milling Machines.
Adams Co., Dubuque, Iowa.
Niles-Bement-Pond Co., New York.
Pratt & Whitney Co., Hartford.
Sellers & Co., Inc., William, Phila.

Mill Supplies.
Dodge Mfg. Co., Mishawaka, Ind.
Powell Co., Wm., Cincinnati.
Robins Conveying Belt Co, Passaic N. J.
Simmons Co., John, New York.
Stephens-Adamson Mfg. Co., Aurora, Ill
Walworth Mfg. Co., Boston.

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Mine Cars.
Jeffrey Mfg. Co., Columbus.
Wellman-Seaver-Morgan Co., Cleveland.

Mining Machinery.
Bradley Pulverizing Co., Boston.
Brown Hoisting Mchy. Co., Cleveland.
Crocker-Wheeler Co., Ampere, N. J.
Dodge Mfg. Co., Mishawaka, Md.
General Electric Co., New York.
Goulds Mfg. Co., Seneca Falls, N. Y.
Ingersoll-Rand Co., New York.
Jeffrey Mfg. Co., Columbus.
Lambert Hoist. Eng. Co., Newark.
Lidgerwood Mfg. Co., New York.
Marion Steam Shovel Co., Marion, O.
McGowan Co., John H., Cincinnati.
Mead-Morrison Mfg. Co., Boston.
Norwalk Iron Wks. Co., Norwalk, Ct.
Power & Mining Mchy. Co., Milwaukee.
Power Specialty Co., New York.
Robins Conveying Belt Co., Passaic, N. J.
Stephens-Adamson Mfg. Co., Aurora, Ill.
Wellman-Seaver-Morgan Co., Cleveland.
Westinghouse Elec. & Mfg. Co., Pittsburg.
Wisconsin Engine Co., Corliss, Wis.

Monel Metal Castings.
Bayonne Casting Co., Bayonne, N. J.

Motors, Electric.
Crocker-Wheeler Co., Ampere, N. J.
Fort Wayne Electric Works, Fort Wayne, Ind.
Garwood Electric Co., Garwood, N. J.
General Electric Co., New York.
Jeffrey Mfg. Co., Columbus.
Northern Elec. Mfg. Co., Madison.
Sprague Electric Co., New York.
Stow Mfg. Co., Binghamton, N. Y.
Triumph Electric Co., Cincinnati.
Westinghouse Elec. & Mfg. Co., Pittsburg.

Motor Parts.
Electric Railway Equipment Co., Cincinnati.

Moulding Machines.
Obermayer Co., S., Cincinnati.
Power Specialty Co., New York.

Name Plates.
Schwerdtle Stamp Co., Bridgeport.

Naphtha Gas Machines.
Am. Gas Furnace Co., New York.

Office Furniture.
Globe-Wernicke Co., Cincinnati, O.

O. H. Furnaces.
Wellman-Seaver-Morgan Co., Cleveland.

O. H. Furnace Charge Machinery.
Wellman-Seaver-Morgan Co., Cleveland.

Ohmmeters.
Weston Elec. Instrument Co., Waverly Park, Newark, N. J.

Oil Burners.
Hauck Mfg. Co., Brooklyn, N. Y.
Parson Mfg. Co., New York.
Petroleum Iron Wks. Co., Sharon, Pa.

Oil and Grease Cups.
Detroit Lubricator Co., Detroit.
Walworth Mfg. Co., Boston.

Oil Engines.
De La Vergne Machine Co., N. Y.
Mietz, August, New York.

Oil—Lubricating.
Kellogg & Co., E. H., New York.

Oil Refining Plants.
Graver Tank Wks., Wm., East Chicago, Ind.
Petroleum Iron Wks. Co., Sharon, Pa.

Oil Pumps.
Detroit Lubricator Co., Detroit.
Wood & Co., R. D., Phila., Pa.

Oil Stones.
Carborundum Co., Niagara Falls, N. Y.
Norton Co., Worcester, Mass.

Oil Tanks.
Chicago Bridge & Iron Wks., Chicago.
Wood & Co., R. D., Phila., Pa.
Wright Mfg. Co., Detroit.

Ore Unloaders.
Wellman-Seaver-Morgan Co., Cleveland.

Ore and Coal Bridges.
Wellman-Seaver-Morgan Co., Cleveland.

Packing.
Boston Belting Co., Boston.
Jenkins Bros., New York.

Paint Graphite.
Obermayer Co., S., Cincinnati.

Paints and Varnishes.
Dixon Crucible Co., Jos., Jersey City.

Paper-Mill Machinery.
Caldwell & Son Co., H. W., Chicago.
Dodge Mfg. Co., Mishawaka, Ind.
Goulds Mfg. Co., Seneca Falls, N. Y.
Jeffrey Mfg. Co., Columbus.
Robins Conveying Belt Co., N. Y.

Patent Attorneys.
Dieterich, C. A., New York.
Evans & Co., Victor J. Washington, D. C.

Pattern-Makers' Machinery.
Fay & Egan Co., Cincinnati.
Pratt & Whitney Co., Hartford.

Pavement Filler.
American Asphaltum & Rubber Co., Chicago.
Barrett Mfg. Co., New York.

Pavement—Wood.
U. S. Wood Preserving Co., New York.

Penstocks.
Graver Tank Wks., Wm., East Chicago, Ind.
Petroleum Iron Works Co., Sharon, Pa.
Walsh's Holyoke Steam Boiler Co., Holyoke, Mass.

Perforated Metal.
Caldwell & Son Co., H. W., Chicago.
Stephens-Adamson Mfg. Co., Aurora, Ill.

Phosphor Bronze.
Phosphor Bronze Smelt. Co., Phila.
Poole Eng'g & Mch. Co., Baltimore.

Pile Drivers.
Ingersoll-Rand Co., New York.

Pinions.
New Process Raw Hide Co., Syracuse.

Pipe.
Abendroth & Root Mfg. Co., Newburgh, N. Y.
Fox & Co., Jno., New York.
Petroleum Iron Wks. Co., Sharon, Pa.
Riter-Conley Mfg. Co., Pittsburg.
Scaife & Sons Co., Wm. B., Pittsburg.
Simmons Co., Jno., New York.
U. S. Cast Iron Pipe & Fdy. Co., New York.
Walworth Mfg. Co., Boston.
Wood & Co., R. D., Phila., Pa.

Pipe Bends.
National Pipe Bending Co., New Haven.
Simmons Co., Jno., New York.
Walworth Mfg. Co., Boston.

Pipe-Cutting and Threading Machines.
Armstrong Mfg. Co., Bridgeport, Conn.
Cox & Sons Co., Bridgeton, N. J.
Hollands Mfg. Co., Erie, Pa.
Niles-Bement-Pond Co., New York.
Saunders' Sons, Inc., D., Yonkers.
Walworth Mfg. Co., Boston.

Pipe—Spiral Riveted.
Abendroth & Root Mfg. Co., Newburgh, N. Y.
Graver Tank Wks., Wm., East Chicago, Ind.

Pipe Fittings, Cast Iron.
Abendroth & Root Mfg. Co., Newburgh, N. Y.
Direct Separator Co., Syracuse, N. Y.
Pelton Water Wheel Co., San Francisco.
Simmons Co., John, New York.
Walworth Mfg. Co., Boston.
Wood & Co., R. D., Phila., Pa.

Pipe Taps & Reamers.
Hollands Mfg. Co., Erie, Pa.
Walworth Mfg. Co., Boston.

Pitch.
Barrett Mfg. Co., New York.

Planers.
Niles-Bement-Pond Co., New York.
Sellers & Co., William, Phila.

Planing Mill Machinery.
Fay & Egan Co., J. A., Cincinnati.

Pneumatic Tools.
American Compressor & Pump Co., New York.
Clayton Air Compress. Wks., N. Y.
Curtis & Co. Mfg. Co., St. Louis.
Helwig Mfg. Co., St. Paul.
Ingersoll-Rand Co., New York.

Poles, Iron and Steel Tubular.
Electric Railway Equipment Co., Cincinnati.
Simmons Co., John, New York.

Polishing Blocks & Wheels.
Carborundum Co., Niagara Falls, N. Y.
Norton Co., Worcester, Mass.

Pop Safety Valves.
McGowan Co., John H., Cincinnati, O
Powell Co., Wm., Cincinnati.

Portable Drilling Machines.
Ingersoll-Rand Co., New York.
Niles-Bement-Pond Co., New York.

Portland Cement.
See Cement.

Powder—Blasting.
Du Pont De Nemours Powder Co., E. I., Wilmington, Del.
Keystone National Powder Co., Emporium, Pa.
National Powder Co., Emporium, Pa.
Sinnamahoning Powder Co., Emporium, Pa.

Powder Mixers.
Dunning, W. D., Syracuse.

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Power-Transmission Mchy.

Almond Mfg. Co., Ashburnham, Mass.
American Pulley Co., Philadelphia.
Brown Hoisting Mchy. Co., Cleveland.
Caldwell & Son Co., H. W., Chicago.
Crocker-Wheeler Co., Ampere, N. J.
Dodge Mfg. Co., Mishawaka, Ind.
General Electric Co., New York.
Hayward Co., The, New York.
Jeffrey Mfg. Co., Columbus.
Mead-Morrison Mfg. Co., Boston.
Morse Chain Co., Ithaca, N. Y.
National Brake & Clutch Co., Boston.
Oneida Steel Pulley Co., Oneida, N. Y.
Philips Pressed Steel Pulley Works, Philadelphia.
Pyott Co., Chicago.
Robins Conveying Belt Co., Passaic, N. J.
Sellers & Co., Inc., William, Phila.
Stephens-Adamson Mfg. Co., Aurora, Ill.
Webster Mfg. Co., Chicago.
Wellman-Seaver-Morgan Co., Cleveland.
Westinghouse Elec. & Mfg. Co., Pittsburg.
Wood & Co., R. D., Philadelphia.

Pressed Steel Pulleys.

American Pulley Co., Philadelphia.

Presses and Dies.

Armstrong Mfg. Co., Bridgeport, Ct.
Niles-Bement-Pond Co., New York.
Pratt & Whitney Co., Hartford.
Watson-Stillman Co., New York.
Wood & Co., R. D., Phila., Pa.

Prospecting Drills.

Ingersoll-Rand Co., New York.

Pulleys, Shafting & Hangers

Am. Tool & Machine Co., Boston.
American Pulley Co., Philadelphia.
Caldwell & Son Co., H. W., Chicago.
Dodge Mfg. Co., Mishawaka, Ind.
Fay & Egan Co., Cincinnati.
Jeffrey Mfg. Co., Columbus, O.
National Brake & Clutch Co., Boston.
Oneida Steel Pulley Co., Oneida, N. Y.
Philips Pressed Steel Pulley Works, Philadelphia.
Poole Eng'g & Mch. Co., Baltimore.
Pyott Co., Chicago.
Robins Conveying Belt Co., Passaic, N. J.
Sellers & Co., Wm., Philadelphia.
Stephens-Adamson Mfg. Co., Aurora, Ill.

Pulleys, Wrought Steel.

American Pulley Co., Philadelphia.
Oneida Steel Pulley Co., Oneida, N. Y.

Pulverizing Mills.

Dunning, W. D., Syracuse.

Pump Governors.

McGowan Co., John H., Cincinnati, O.

Pumping Engines.

McGowan Co., John H., Cincinnati, O

Pumps and Pumping Machy.

Alberger Condenser Co., New York.
American Compressor & Pump Works, New York.
Buffalo Forge Co., Buffalo.
Cameron Steam Pump Works, N. Y.
De La Vergne Mach Co., New York.
Deming Co., Salem, Ohio.
Goulds Mfg. Co., Seneca Falls, N. Y.
Ingersoll-Rand Co., New York.
McGowan Co., John H., Cincinnati.
Mietz, August, New York.
Morris Co., I. P., Philadelphia.
Morris Machine Works, Baldwinsville, N. Y.
Pelton Water Wheel Co., Oakland, Cal.
Rife Engine Co., New York.
Watson-Stillman Co., New York.
Wheeler Condenser & Eng'g Co., Carteret, N. J.
Wisconsin Engine Co., Corliss, Wis.
Wood & Co., R. D., Phila., Pa.

Pump Pressure Regulator.

D'Este Co., Julian, Boston.

Pumps, Syphon.

McGowan Co., John H., Cincinnati, O.

Punching & Shearing Mchy.

Buffalo Forge Co., Buffalo.
Morgan Construction Co., Worcester.
Niles-Bement-Pond Co., New York.
Sellers & Co., Inc., William, Phila.
Wood & Co., R. D., Philadelphia.

Pyrometers.

Bristol Co., Waterbury, Conn.
Engelhard, Charles, New York.
Queen & Co., Philadelphia.
Schaeffer & Budenberg Mfg. Co., Brooklyn.
Taylor Instrument Companies, Rochester, N. Y.

Quarry Machinery.

Brown Hoisting Mchy Co., Cleveland.
Flory Mfg. Co., S., Bangor, Pa.
Ingersoll-Rand Co., New York.
Lambert Hoist. Eng. Co., Newark.
Lidgerwood Mfg. Co., New York.
McGowan Co., John H., Cincinnati.
Mead-Morrison Mfg. Co., Boston.
Northern Engineering Works, Detroit.
Robins Conveying Belt Co., Passaic, N. J.

Quartz Glass.

Engelhard, Charles, New York.

Racks—Machine Cut.

Nuttall Co., R. D., Pittsburg.

Rail Braces.

Rail Joint Co., New York.

Railings.

Anchor Post Iron Works, New York.

Rail Joints.

Rail Joint Co., New York.

Railway Shop Machinery.

Brown Hoisting Mchy. Co., Cleveland.
Dodge Mfg. Co., Mishawaka, Ind.
Fay & Egan Co., Cincinnati.
Niles-Bement-Pond Co., New York.
Norwalk Iron Works, So. Norwalk, Ct.
Pratt & Whitney Co., Hartford.
Sellers & Co., Inc., William, Phila.
Stow Mfg. Co., Binghamton, N. Y.

Rawhide Gears.

New Process Raw Hide Co., Syracuse.

Razor Hones.

Carborundum Co., Niagara Falls, N. Y.

Ready Roofing.

Barrett Mfg. Co., New York.

Reamers.

Ingersoll-Rand Co., New York.
Pratt & Whitney Co., Hartford.
Walworth Mfg. Co., Boston.

Resistance Banks and Units.

Elec. Controller & Mfg. Co., Cleveland.

Rheostats.

Simplex Elec. Heating Co., Cambridge, Mass.

Riveting Machines.

Ingersoll-Rand Co., New York.
Niles-Bement-Pond Co., New York.
Sellers Co., Wm., Inc., Phila.
Wood & Co., R. D., Phila., Pa.

Rock Breakers.

Mead-Morrison Mfg. Co., Boston.
Robins Conveying Belt Co., Passaic, N. J.

Rolling Mill Machinery.

Crocker-Wheeler Co., Ampere, N. J.
Dodge Mfg. Co., Mishawaka, Ind.
Morgan Construction Co., Worcester.
Niles-Bement-Pond Co., New York.
Poole Eng'g & Mch. Co., Baltimore.
Robins Conveying Belt Co., Passaic, N. J.
Wellman-Seaver-Morgan Co., Cleveland.
Wisconsin Engine Co., Corliss, Wis.

Roofing.

Barrett Mfg. Co., New York.
Chicago Bridge & Iron Wks., Chicago.

Roofing Materials.

Barrett Mfg. Co., New York

Rope.

American Mfg. Co., New York.

Rope Transmission.

American Mfg. Co., New York.
Caldwell & Son Co., H. W., Chicago.
Dodge Mfg. Co., Mishawaka, Ind.
Jeffrey Mfg. Co., Columbus.
Phosphor Bronze Smelting Co., Philadelphia.
Pyott Co., Chicago.
Stephens-Adamson Mfg. Co., Aurora, Ill.

Rubber Goods.

Boston Belting Co., Boston.
Jenkins Bros., New York.

Rubbing and Sharpening Stones.

Norton Co., Worcester.

Sand.

Mfrs. Supply House, Erie, Pa.

Sand Mixers and Sifters.

Obermayer Co., S., Cincinnati.
Sellers & Co., William, Phila.

Sash Operating Device.

Detroit Steel Products Co., Detroit, Mich.
Hitchings & Co., New York.
Lord & Burnham Co., Irvington-on-Hudson, N. Y.

Saw-Mill Machinery.

Curtis & Co. Mfg. Co., St. Louis.
Dodge Mfg. Co., Mishawaka, Ind.
Fay & Egan Co., J. A., Cincinnati.
Jeffrey Mfg. Co., Columbus.

Saws, Hack.

Niles-Bement-Pond Co., New York.

Scales.

Richardson Scale Co., New York.

Screens, Mining.

Jeffrey Mfg. Co., Columbus.
Ludlow-Saylor Wire Co., St. Louis.
Pyott Co., Chicago.
Stephens-Adamson Mfg. Co., Aurora, Ill.

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Screw Machines.
Jones & Lamson Mch. Co., Springfield, Vt.
National Acme Mfg. Co., Cleveland.
Niles-Bement-Pond Co., New York.
Pratt & Whitney Co., Hartford.

Screw Plates.
Card Mfg. Co., S. W., Mansfield, Mass.
Walworth Mfg. Co., Boston.

Separators, Pneumatic.
Sturtevant Co., B. F., Hyde Park, Mass.

Separators, Steam and Oil.
American Tool & Mch. Co., Boston.
Austin Separator Co., Detroit.
D'Este Co., Julian, Boston.
Direct Separator Co., Syracuse.
Harrison Safety Boiler Wks., Phila.
Hoppes Mfg. Co., Springfield O.
McGowan Co., John H., Cincinnati, O.
Watson & McDaniel Co., Phila.
Webster & Co., Warren, Camden, N.J.
Wright Mfg. Co., Detroit.

Shaft Couplings, Flexible.
Elec. Controller & Mfg. Co., Cleveland

Shapers.
Niles-Bement-Pond Co., New York.
Sellers & Co., Inc., William, Phila.

Sharpening Stones.
Carborundum Co., Niagara Falls, N.Y.
Norton Co., Worcester, Mass.

Sheathing Papers.
Barrett Mfg. Co., New York.

Shop Floors.
U. S. Wood Preserving Co., New York.

Shutters (Fire).
Kinnear Mfg. Co., Columbus.

Skylights.
Van Noorden Co., E., Boston.

Slate Machinery.
Flory Mfg. Co., S., Bangor, Pa.
Morris Co., I. P., Philadelphia.

Smelting Pots & Ladles.
Hollands Mfg. Co., Erie, Pa.

Smoke-Prevention System.
Scharf Co., G. H., Ypsilanti, Mich.

Special Machinery.
Bruce-Macbeth Engine Co., Cleveland, O.
Niles-Bement-Pond Co., New York.

Spiral Gears.
Nuttall Co., R. D., Pittsburg.

Stacks.
Abendroth & Root Mfg. Co., Newburgh, N. Y.
Chicago Bridge & Iron Wks., Chicago.
Graver Tank Wks., Wm., East Chicago, Ind.
Petroleum Iron Wks. Co., Sharon, Pa.
Riter-Conley Mfg. Co., Pittsburgh.
Smith & Son Co., Sam'l, Paterson, N. J.
Walsh's Boiler Wks., Holyoke, Mass.

Stamps—Steel, Alphabets and Figures.
Schwerdtle Stamp Co., Bridgeport.

Stand Pipes.
Chicago Bridge & Iron Wks., Chicago.
Graver Tank Wks., Wm., East Chicago, Ind.
Petroleum Iron Wks. Co., Sharon, Pa.
Tippett & Wood, Phillipsburg, N. J.
Walsh's Boiler Wks., Holyoke, Mass.
Wood & Co., R. D., Phila., Pa.

Steam Engine Indicators.
Schaeffer & Budenberg Mfg. Co., Brooklyn, N. Y.

Steam Fitters' Supplies.
Simmons Co., John, New York.

Steam Hammers.
Niles-Bement-Pond Co., New York.
Sellers & Co., Inc., William, Phila.

Steam-Regulat'n Appliances.
D'Este Co., Julian, Boston.
Harrison Safety Boiler Wks., Whila.
Jenkins Bros., New York.
Powell Co., Wm., Cincinnati.
Power Specialty Co., New York.
Simmons Co., John, New York.
Walworth Mfg. Co., Boston.
Watson & McDaniel Co., Phila.

Steam Shovels.
Bucyrus Co., Sth. Milwaukee, Wis.
Marion Steam Shovel Co., Marion, O.
Mead-Morrison Mfg. Co., Boston.

Steam Specialties.
Austin Separator Co., Detroit.
Bayonne Casting Co., Bayonne, N. J.
Industrial Inst. Co., Foxboro, Mass.
McGowan Co., John H., Cincinnati, O.
Powell Co., Wm., Cincinnati.
Schaeffer & Budenberg Mfg. Co., Brooklyn, N. Y.
Simmons Co., John, New York.
Walworth Mfg. Co., Boston.
Wright Mfg. Co., Detroit.

Steam Traps.
Albany Steam Trap Co., Albany, N. Y.
American Blower Co., Detroit.
D'Este Co., Julian, Boston.
Direct Separator Co., Syracuse, N.Y.
Kitts Mfg. Co., Oswego, N. Y.
Morehead Mfg. Co., Detroit, Mich.
Sturtevant Co., B. F., Hyde Park, Mass.
Walworth Mfg. Co., Boston.
Watson & McDaniel Co., Phila.
Wright Mfg. Co., Detroit.

Steam Fitters' Supplies.
Powell Co., Wm., Cincinnati.
Walworth Mfg. Co., Boston.

Steam Hot Blast Apparatus.
American Blower Co., Detroit.
Sturtevant Co., B. F., Hyde Park, Mass.

Steel.
Inland Steel Co., Chicago.
Jessop & Sons, Wm., New York.
Taylor Iron & Steel Co., High Bridge, N. J.
Walworth Mfg. Co., Boston.
Wyman & Gordon, Worcester.

Steel Balls.
American Ball Co., Providence.

Steel Doors.
Dahlstrom Metallic Door Co., Jamestown, N. Y.

Steel, High Speed.
Jessop & Sons, Wm., New York.
Wyman & Gordon, Worcester.

Steel-Plant Machinery.
Wellman-Seaver-Morgan Co., Cleveland.

Steel Plate Construction.
Chicago Bridge & Iron Wks., Chicago.
Graver Tank Wks., Wm., East Chicago, Ind.

Steel, Vanadium.
American Vanadium Co., Pittsburg.

Stencils.
Schwerdtle Stamp Co., Bridgeport.

Stokers—Mechanical.
Am. Ship Windlass Co., Providence, R. I.
Babcock & Wilcox Co., New York.
Harrisburg Foundry & Mach. Wks., Harrisburg, Pa.
Parson Mfg. Co., New York.
Under-Feed Stoker Co., Chicago.
Westinghouse Mch. Co., Pittsburg.

Storage Batteries.
Westinghouse Mch. Co., Pittsburg.

Structural Iron Work.
Brown Hoisting Mchy Co., Cleveland.
Chicago Bridge & Iron Wks., Chicago.
Northern Engineering Works, Detroit.
Riter-Conley Mfg. Co., Pittsburg.
Scaife & Sons Co., Wm. B., Pittsburg.

Sugar-House Machinery.
Am. Tool & Mch. Co., Boston.

Superheaters.
Babcock & Wilcox Co., New York.
Power Specialty Co., New York.

Switchboards.
Crocker-Wheeler Co., Ampere, N. J.
Western Electric Co., Chicago.

Switches, Electric.
Electric Controller & Mfg. Co., Cleveland, O.

Tachometers.
Schaeffer & Budenberg Mfg. Co., Brooklyn.
Industrial Inst. Co., Foxboro, Mass.

Tanks.
Chicago Bridge & Iron Wks., Chicago.
Corcoran, Inc., A. J., New York.
Dodge Mfg. Co., Mishawaka, Ind.
Graver Tank Works, Wm., East Chicago, Ind.
Holyoke Steam Boiler Works, Holyoke, Mass.
Kennicott Company, Chicago.
Petroleum Iron Works Co., Sharon, Pa.
Riter-Conley Mfg. Co., Pittsburg.
Scaife & Sons Co., Wm. B., Pittsburg.
Smith & Son Co., Sam'l, Paterson, N. J.
Tippett & Wood, Phillipsburg, N. J.
Walsh's Boiler Wks., Holyoke, Mass.
Wood & Co., R. D., Phila., Pa.

Taps and Dies.
Card Mfg. Co., S. W., Mansfield, Mass.
Pratt & Whitney Co., Hartford.
Walworth Mfg. Co., Boston.

Temperature Regulators.
D'Este Co., Julian, Boston.

Tenoning Machines.
Fay & Egan Co., J. A., Cincinnati.

Thermometers.
Bristol Co., Waterbury, Conn.
Queen & Co., Philadelphia.
Schaeffer & Budenberg Mfg. Co., Brooklyn.
Standard Thermometer Co., Boston, Mass.
Taylor Instrument Companies, Rochester, N. Y.
Wilder Co., Charles, Troy, N. Y.

Thermometers, Dial Type.
Industrial Instrument Co., Foxboro, Mass.

Time Checks.
Schwerdtle Stamp Co., Bridgeport.

Time Recorders.
International Time Recording Co., Endicott, N. Y.

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Curtis & Co., Mfg. Co., St. Louis.
Maris Bros., Philadelphia.

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Niles-Bement-Pond Co., New York.
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Trucks, Hand.

New York Revolving Portable Elevator Co., Jersey City, N. J.

Trucks, Storage Battery Auto.

Westinghouse Mach. Co., Pittsburg.

Tumbling Barrels.

Northern Engineering Works, Detroit.

Tumbling Mills.

Obermayer Co., S., Cincinnati.

Tubular Poles—Iron & Steel.

Electric Railway Equipment Co., Cincinnati.
Simmons Co., John, New York.

Turbines, Steam.

General Electric Co., Schenectady.
Hooven-Owens Rentschler Co., Hamilton, O.
Morris Co., I. P., Philadelphia.
Sturtevant Co., B. F., Hyde Park, Mass.
Westinghouse Mch. Co., Pittsburg.
Wheeler Condenser & Eng'g Co., Carteret, N. J.
Wing Mfg. Co., L. J., New York.

Turbines, Water.

J. & W. Jolly, Inc., South Holyoke, Mass.
Leffel & Co., James, Springfield, O.
Morgan Smith Co., S., York, Pa..
Pelton Water Wheel Co., San Francisco.
Wellman-Seaver-Morgan Co., Cleveland.

Turn Tables.

Chicago Bridge & Iron Wks., Chicago.
Mead-Morrison Mfg. Co., Boston.
Northern Engineering Works, Detroit.
Sellers & Co., Inc., Wm., Phila.
Tippett & Wood, Phillipsburg, Pa.

Turret Heads.

Almond Mfg. Co., Ashburnham, Mass.

Turret Lathes.

American Tool & Mch. Co., Boston.
Jones & Lamson Mch. Co., Springfield, Vt.
Niles-Bement-Pond Co., New York.
Pratt & Whitney Co., Hartford.

Twist Drills.

Pratt & Whitney Co., Hartford.

Unions.

Dart Mfg. Co., E. M. Providence, R. I.
Walworth Mfg. Co., Boston.

Vacuum and Draft Gages.

Bristol Co., Waterbury, Conn.
Industrial Inst. Co., Foxboro, Mass.
Schaeffer & Budenberg Mfg. Co., Brooklyn, N. Y.

Vacuum Pumps.

American Compressor & Pump Co., N. Y.
Buffalo Forge Co., Buffalo.
Goulds Mfg. Co., Seneca Falls, N. Y.
McGowan Co., John H., Cincinnati.
Wheeler Condenser & Eng'g Co., Carteret, N. J.

Valves, Blow-off.

Simmons Co., Jno., New York.
Walworth Mfg. Co., Boston.

Valves—Gas, Steam and Water.

Bayonne Casting Co., Bayonne, N. J.
D'Este Co., Julian, Boston.
Detroit Lubricator Co., Detroit.
Jenkins Bros., New York.
McGowan Co., John H., Cincinnati, O.
Powell Co., Wm., Cincinnati.
Ross Valve Mfg. Co., Troy.
Simmons Co., John, New York.
Walworth Mfg. Co., Boston.
Watson & McDaniel Co., Phila.
Wood & Co., R. D., Phila., Pa.

Valves, Reducing.

D'Este Co., Julian, Boston.
Kitts Mfg. Co., Oswego, N. Y.
Ross Valve Mfg. Co., Troy, N. Y.
Simmons Co., Jno. New York.
Watson & McDaniel Co., Philadelphia.

Vanadium Alloys.

American Vanadium Co., Pittsburg.

Vanadium Steels.

American Vanadium Co., Pittsburg.

Ventilating Apparatus.

American Blower Co., Detroit.
Bristol Co., Waterbury, Conn.
Buffalo Forge Co., Buffalo.
Green Fuel Economizer Co., Matteawan, N. Y.
Hitchings & Co., New York.
Lord & Burnham Company, New York.
Massachusetts Fan Co., Watertown, Mass.
Sirocco Engng. Co., Detroit, Mich.
Sturtevant Co., B. F., Hyde Park, Mass.
Western Electric Co., Chicago.
Wing Mfg. Co., L. J., New York.

Vises.

Hollands Mfg. Co., Erie, Pa.
Walworth Mfg. Co., Boston.

Voltmeters.

Bristol Co., Waterbury, Conn.
Western Electric Co., Chicago.
Weston Elec. Instrument Co., Waverly Park, Newark.

Water Columns.

Walworth Mfg. Co., Boston.
Wright Mfg. Co., Detroit.

Water Cooling Towers.

Wheeler Condenser & Eng'g. Co., Carteret, N. J.

Waterproofing Concrete Floor Dressing

Glidden Varnish Co., Cleveland.

Waterproofing Materials.

Barrett Mfg. Co.

Water Purifying Apparatus.

Booth Co., L. M., New York.
Dodge Mfg. Co., Mishawaka, Ind.
Graver Tank Wks., Wm., East Chicago, Ind.
Harrison Safety Boiler Wks., Phila.
Scaife & Sons Co., Wm. B., Pittsburg.

Water Softening Apparatus.

Booth Co., L. M., New York.
Dodge Mfg. Co., Mishawaka, Ind.
Graver Tank Wks., Wm., East Chicago, Ind.
Harrison Safety Boiler Wks., Phila.
Kennicott Company, Chicago.
Northern Water Softener Co., Madison, Wis.
Scaife & Sons Co., Wm. B., Pittsburg.

Water Towers, Iron & Steel.

Chicago Bridge & Iron Wks., Chicago.
Tippett & Wood, Phillipsburg, N. J.

Water-Wheels.

J. & W. Jolly, Inc., South Holyoke, Mass.
Leffel & Co., Jas., Springfield, O.
Pelton Water Wheel Co., San Francisco.
Poole Eng'g & Mch. Co., Baltimore.
Power Specialty Co., New York.
Smith Co., S., Morgan, York, Pa.
Wellman-Seaver-Morgan Co., Cleveland.
Wood & Co., R. D., Phila.

Water-Works Pumping Mch.

Buffalo Forge Co., Buffalo.
Foos Gas Engine Co., Springfield, O.
Goulds Mfg. Co., Seneca Falls, N. Y.
McGowan Co., John H., Cincinnati, O.
Wisconsin Engine Co., Corliss, Wis.
Wood & Co., R. D., Phila., Pa.

Water-Works Supplies.

Power Specialty Co., New York.
Simmons Co., John, New York.
Walworth Mfg. Co., Boston.

Welding, Electric.

Electric Controller & Mfg. Co., Cleveland, O.

Well Drilling Machines.

Williams Bros., Ithaca, N. Y.

Well Supplies.

Williams Bros., Ithaca, N. Y.

Whistles.

Powell Co., Wm., Cincinnati.
Schaeffer & Budenberg Mfg. Co., Brooklyn.
Walworth Mfg. Co., Boston.

Windows.

Detroit Steel Products Co., Detroit, Mich.
Van Noorden Co., E., Boston.

Wire-Drawing Machinery.

Morgan Construction Co., Worcester.

Wire Cloth and Screen.

Ludlow-Saylor Wire Co., St. Louis.

Wire Lath.

American Steel & Wire Co., Chicago.
Ludlow-Saylor Wire Co., St. Louis.

Wire Rope.

Jeffrey Mfg. Co., Columbus.
Phosphor Bronze Smelting Co., Ltd., Philadelphia.

Wire Vanadium.

American Vanadium Co., Pittsburg.

Wood-Working Machinery.

Fay & Egan Co., J. A., Cincinnati.
Ingersoll-Rand Co., New York.

Worm Gearing.

Nuttall Co., R. D., Pittsburg.

Wrenches.

Simmons Co., Jno., New York.
Walworth Mfg. Co., Boston.
Wood & Co., R. D., Phila.

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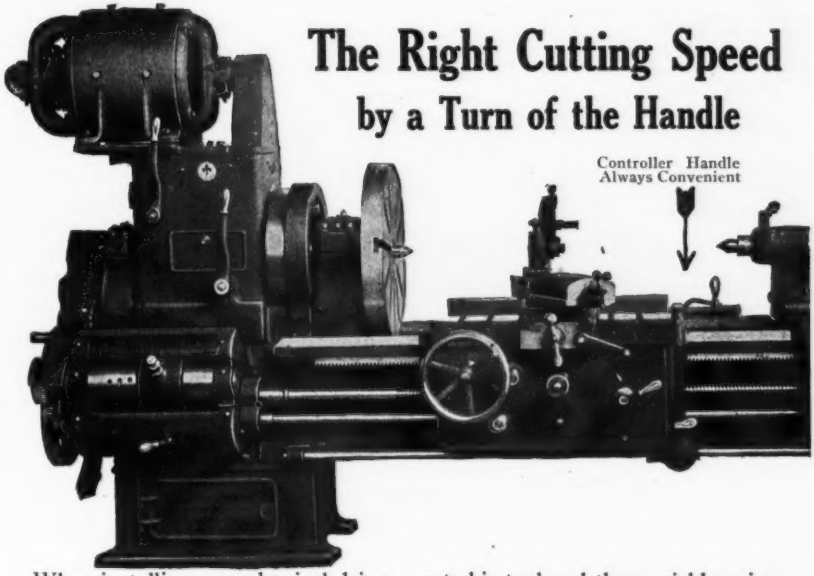

The Right Cutting Speed
by a Turn of the Handle

When installing a mechanical drive, the designing engineer sometimes knows the kind of work to be done and can select pulley diameters to approximate the best cutting speeds.

This is not so with machine repair shops, where the work and metal are constantly changing. Here it is practically impossible to foretell the economical cutting speeds. Necessarily a compromise is made, and a mechanical drive installed with speed steps that are often unsuited to the work being done.

For all work requiring variable speed the General Electric Motor Drive gives the best cutting speed for any cut on any kind of metal by the mere turn of a handle placed where most convenient.

The mechanic sets up his work, sets his tool and then quickly raises the speed until the tool has all it can stand. This saves time—at least an hour or two a day.

No time lost hunting for shifter sticks and no unsuccessful attempts at jumping the belt up or down only to find the speed selected has burnt and taken the edge off the tool. No costly rolling stock tied up through loss of time when scheduled for a run. Just *the right speed instantly by a turn of the handle.*

General Electric Motor Drive

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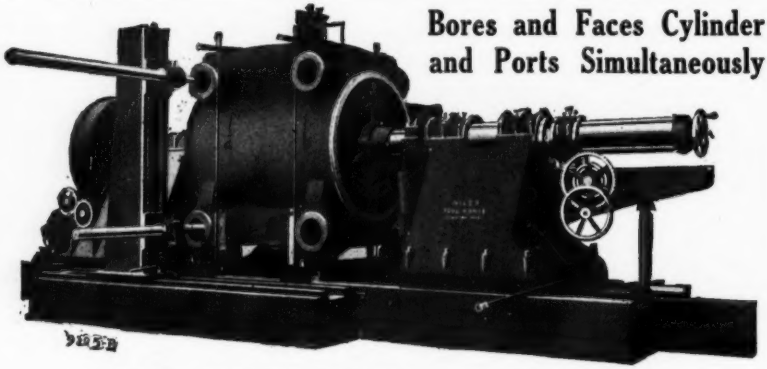

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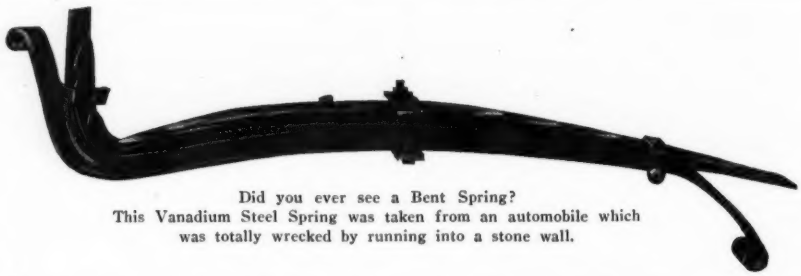

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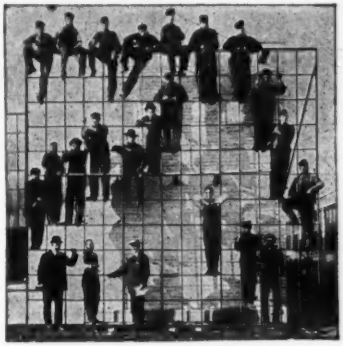

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THE CURRENT RECORD OF
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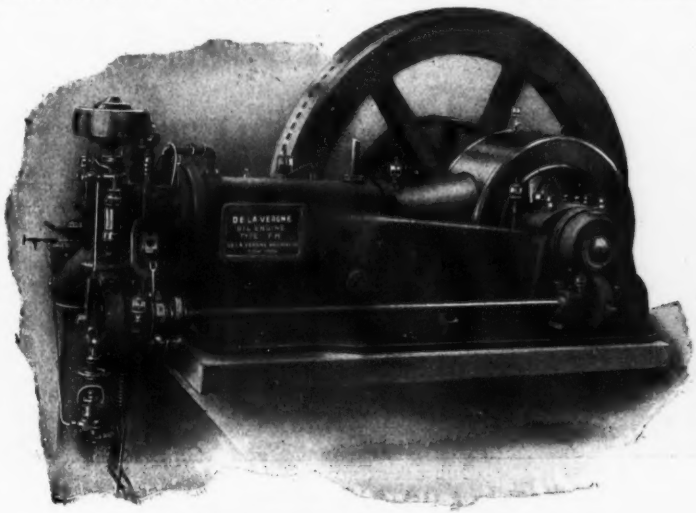
The De La Vergne Engine Company.

THE accompanying illustration shows the De La Vergne engine Type "F. H.," made in sizes of 85 H. P. to 350 H. P. The builders offer these engines subject to a guarantee that when operating at sea level with crude oil, distillate, or cheap fuel oil, 16° Baumé or better, they will develop continuously their full rated horse-power, the same to be measured on the wheel shafts.

The advantages claimed for this engine are : (1) Low fuel expense. Under the ordinary conditions generally existing, and the usual ruling prices of coal and fuel oil, the fuel expense of this engine is the lowest available, taking into account even steam turbines of large capacity. (2) Simplicity. The engine, compressed air apparatus for starting, small water circulating system, and the oil storage tank constitute the



DE LA VERGNE TYPE "F. H." OIL ENGINE.

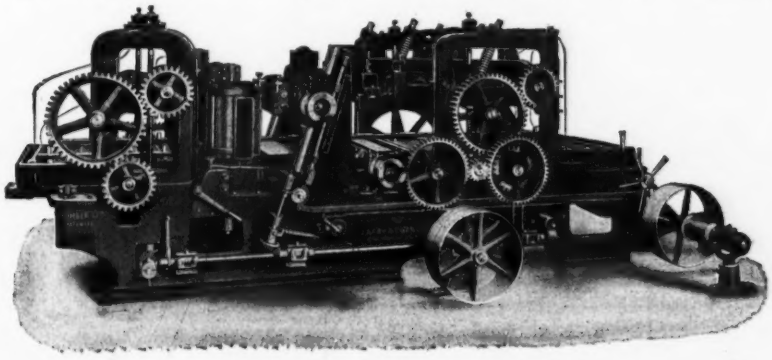
entire plant, as against a high-class steam plant with boilers, pumps, heaters, economizers and complicated condensing apparatus. (3) No stand-by losses. When the engine is shut down and the oil supply valve closed, operating expense ceases until ready to start again. (4) Minimum attendant charge. A licensed engineer is not required to operate this engine, nor is there need for firemen or other helpers. A small part of the time of one man constitutes the whole labor charge. (5) No handling of coal or removing of ashes. The fuel oil is preferably handled by gravity, direct from the tank car from which it is received from an underground storage tank, from which it is pumped by the engine itself. No refuse of any kind is produced from the operation of this engine. (6) Absence of excessive pressure in engines. High pressures mean frequent breakages and shutdowns. It is claimed that the average maintenance charge with this engine is less than with the steam engine. The builders, the De La Vergne Machine Co., New York City, have issued Bulletin No. 101, illustrating and describing type "F. H." oil engines in detail and it will be sent free on request.

The Hauck Burner.

THE accompanying illustration shows the Hauck burner, a device for the transformation of crude oil and compressed air or oxygen into a heavy body of gas, resulting in complete combustion. These results are obtained by placing crude, fuel, or kerosene oil in a tank under pressure of from 15 to 100 pounds per square inch, connecting the

THE HAUCK BURNER.

oil tank with a line of tubing which conveys the fuel oil to the burner, where it is formed into a heavy gas, giving a strong, blue flame, and a most intense heat. The manufacturers draw attention to the custom of some makers of burners to measure their machines by the length of the flame. The Hauck burner obtains complete combustion, giving a comparatively short and powerful flame; it is, therefore, absolutely safe and does not endanger the shop or workmen. The Hauck Manufacturing Co., 140 Livingston street, Brooklyn, have issued a bulletin entitled "Series 30," showing many instructive illustrations of the use of the Hauck burner for locomotive and steel car repairs, in boiler shops, for flanging or off-setting, pipe bending, in machine shops, and shipyards and a combination forge.



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WE present herewith a new and improved machine for meeting the demand of large lumber mills, car shops, shipyards and other places where large timbers are worked and where they require a powerful machine with roll feed, able to plane and joint dimension timbers on four sides, at one operation. It is also adapted for every variety of heavy surface planing. This No. 125 double cylinder timber dresser is said to be the most powerful timber dresser ever built. The frame is of massive construction, has plate sides, and is well braced to prevent vibration when working to its full capacity. It will plane long timbers on two or four sides up to 30 inches wide and 16 inches thick, or two sides and one edge of two timbers 13 inches wide and 16 inches thick. The feeding mechanism on this machine is one of the finest and most improved ever placed on a tool of this kind. It consists of six 8-inch rolls, the two upper rolls at the feeding-in end being divided and center geared, insuring a very powerful drive. The rolls are carried in heavy housings mounted on a saddle, raising and lowering by power for different thicknesses. The feeding-out roll is geared on both ends and mounted in a heavy housing carried on a saddle which slides on the stands. Pressure is applied to roll by means of two double volute springs. All upper rolls are geared to drive down, insuring a very powerful feed. For further information concerning this machine, you are requested to write the manufacturers, J. A. Fay & Egan Co., 212-232 West Front street, Cincinnati, Ohio.

Monel Metal.

The alloy recently introduced by the Orford Copper Company, known as "Monel Metal," is rapidly becoming a leading non-corrosive metal, and much interest in its physical properties is now being evinced by the metal trade. Monel Metal is a natural alloy of copper and nickel in which nickel predominates (nickel 68%). As the alloy is made directly from the ore without separating the constituent metals, there results an intimate mixture such as is difficult to obtain in the usual method of producing alloys.

In appearance, Monel Metal cannot be distinguished from pure nickel and takes the same finish. Its great strength, together with its extreme non-corrosiveness, adapts it for uses for which an alloy has long been sought and for which there is a constantly increasing demand in marine work for parts that come in contact with salt water or waters that cause corrosion. The United States Government is specifying Monel Metal for construction work under the Navy Department, for such parts as propellers, pump linings and pump rods.

While the physical properties of this alloy excel those of mild steel, still it machines very easily. A lathe can be run at the same speed on Monel Metal as on mild steel. The metal can be forged, soldered, brazed or electrically welded. The great strength of Monel Metal, combined with its high ductility and non-corrosiveness, admirably adapts it for use where the non-corrosiveness of a bronze together with the high strength of steel is desirable. Monel Metal rods in service have shown no scoring in instances where bronze and steel were rapidly cut out. Repacking is reduced to a minimum and this fact, together with its resistance to alternating stresses, make it the best metal known for pump and piston rods.

Monel Metal is now commercially produced in a variety of forms, such as ingots, sheets, rods, wire and castings.

Owing to its high melting point, special equipment and some experience with the metal is necessary in order to produce castings successfully.

The Bayonne Casting Company, Bayonne, N. J., makes a specialty of casting Monel Metal and now produces such castings as propeller wheels, marine fittings, acid handling apparatus, exhaust fans for acid gases, pumps, plungers, valve seats, rods, gears, and pickling apparatus; in fact, any casting which should combine great strength with non-corrosiveness. The castings are sound, clean, true to pattern. They can be readily machined, forged and electrically welded.

Special Feed Water Heater for Condensate and Returns.

WHERE condensate from a surface condenser or returned from heating or drying systems form a considerable part of the boiler feed supply, it is often necessary to make up the full amount of feed water required by the boiler by adding water which is of a scale-forming or corrosive nature. On account of the disproportionately large cost of putting in a softening system of the usual type for this small amount of water it is usually fed to the boilers without treatment, with the result that scale is formed in the boilers. While the scale so formed is less than the amount that would be deposited if raw water alone were used for the boiler feed supply, the scale is, on the other hand, apt to be hard, and, because of its slow formation, apt to be overlooked, resulting frequently in the unexpected burning of plates and tubes, leakage at seams and tube ends, etc. This problem has been attacked by the Harrison Safety Boiler Works, 3138 North 17th street, Philadelphia, Pa., in their Engineering Leaflet No. 7, entitled "Combination Feed Water Heaters and Softening Sys-

tems," which describes an apparatus designated for plants in which such conditions obtain. This apparatus differs from their Sorge-Cochrane hot process system in that provision is made for heating the two separate water supplies independently, and for treating only one with a reagent. The condenser discharge or other returns, after passing over heating trays, pass directly to the pump supply chamber or pure water compartment, whereas the raw water, after heating and mixing with the reagent, falls into a spacious sedimentation chamber and afterwards passes through a filter bed before entering the pure water compartment. To insure a continuous supply of water to the boilers in case of clogging of the filters, there is an automatic by-pass which, in case the level of the water in the pump supply chamber should fall below a certain level, will supplement with sufficient hot, treated water to supply the pumps. In a hot process system, the "temporary" hardness, or carbonates, are precipitated by heat, and the only reagent required is that needed for the transformation of "permanent" hardness, such as sulphates, chlorides, nitrates, acids, etc. Due to the use of only one reagent, the management of the apparatus is much simplified, no complicated chemical analyses being required, as where two reagents must be proportioned to the varying requirements of the water. The apparatus has the further great advantage over a cold process system that it performs, in addition, the functions of the feed water heater which should be installed in any case. For this purpose it can be adapted to any of the various forms assumed by open feed water heaters, that is, it can be used as heater and receiver in connection with an exhaust steam heating system, etc. This pamphlet should prove of interest to all engineers having to do with steam plants where scale-forming water is encountered.

The Phoenix Little Giant.

THE Phoenix "Little Giant" turbine wheel is a double wheel, the lower part being independent of the upper part, both parts being keyed to the same shaft; or, strictly speaking, two wheels with their backs together on the same shaft, one discharging downward and the other upward.

The scroll of this wheel is cast in one piece and is fitted with hand holes, which gives ready access to the wheel to remove obstructions without detaching the spout or disturbing the wheel.

THE PHOENIX "LITTLE GIANT" TURBINE WHEEL.

The gate box is of cast iron, bolted firmly to the case. The surface of the gate is planed, also the seat or ways upon which it slides. The pressure of water will always keep them together, and as both surfaces are planed and straight, they will always keep tight.

The gate stem is turned its entire length and moves perpendicularly through a stuffing box on the top of

gate frame. The stuffing box is filled with packing to avoid leakage around the gate stem.

These wheels are furnished with and without division plate. The division plate separates the upper and lower sections of the wheel, so in case of a scarcity of water the gate of wheel can be raised to this division plate, using one-half of wheel and one-half the quantity of water and at the same time get within 2 per cent of as good percentage of the power used as when using the whole wheel.

By the curved or hooked shape of the bucket, curving towards the stream, the water has a steady unbroken flow from the time it enters the wheel until it is discharged. The water in the scroll, by entering the wheel with a greater velocity than that with which the wheel is moving, imparts to it greater force. The shape of the bucket where the water enters is such that the water moves in the same direction as the motion of the wheel, and therefore the friction of water against the bucket at this point is helping instead of retarding the power; hence an advantage over wheels where the friction acts in opposite direction to the motion of the wheel. The friction at place of discharge is the same as in most other wheels—that is, in opposite direction to the motion of the wheel—but this wheel being seven-tenths the diameter, the friction has only seven-tenths the leverage, and has only seven-tenths the surface to wear between the periphery of the wheel and case, consequently only seven-tenths the leakage. For instance, a Phoenix Little Giant wheel, fourteen inches in diameter uses the same amount of water and gives the same amount of power that a "first-class flume wheel" would give from twenty to twenty-four inches in diameter.

Further particulars of this wheel may be had from Munson Bros. Co., Utica, N. Y.

Personal.

—Lucius I. Wightman, for the past six years advertising manager for the Ingersoll-Rand Company, 11 Broadway, New York, has resigned his position, the resignation taking effect August 1. He will open an office in New York as an independent specialist in machinery advertising, handling the accounts of manufacturers of machinery and engineering products. Mr. Wightman brings to his new enterprise qualifications peculiarly fitting him for this line of work. To his long experience in managing one of the largest advertising accounts and publicity departments in the machinery field, he joins a prior experience of years in practical mechanical and electrical engineering, construction work, machine design and manufacture, and machinery selling. He is a graduate engineer, the author of a text-book on compressed air, and an authority on compressed air subjects.

—Sylvester S. Howell has become associated with Paul M. Chamberlain, engineer, Marquette Building, Chicago, under the firm name of Chamberlain & Howell. The firm will carry on the designing and consulting engineering practice established by Mr. Chamberlain.

Industrial Notes.

—On account of its constantly increasing business as a newspaper and magazine advertising agency, the Franklin P. Shumway Co., 373 Washington street, Boston, Mass., has found it necessary to enlarge its facilities. This agency was founded by Franklin P. Shumway thirty years ago and numbers among its many clients such firms as the American Hide & Leather Co., Bigelow Carpet Co., Bradley Pulverizing Co., Gurney Heater Manufacturing Co., Knox Automobile Co., the Pacific Mills, and M. Steinert & Sons Co.

—Northern Engineering Works, Detroit, Mich., crane builders, report that they have recently installed in the power stations of the Tunnel and Terminal

Ry. Co., of New York, two 25-ton, 40-ft. span traveling Northern Cranes, and one of 10 tons capacity.

—Arrangements have been made by the C. W. Hunt Company, New York, builders of coal handling, conveying and hoisting machinery, by which their business on the Pacific Coast will be handled by the San Francisco Bridge Co., with offices at 865 Monadnock Building, San Francisco. The company has just completed a naval coaling station in San Francisco Bay for the U. S. Government.

—The Magnolia Metal Co., 118 Bank street, New York, offer a practical engineer pocket-book brought up-to-date, containing 680 pages and treating on over 2,000 mechanical and engineering subjects. It is offered at the very low price of 40 cents, postage prepaid to all parts of the United States, Canada, and Mexico, or wherever postage on it does not exceed domestic rates.

—The Red River Power Company of Grand Forks, N. D., has announced substantial reduction in gas and electric rates and that improvements aggregating upwards of $100,000 will be made this season. The Red River Power Company is the new name of the Grand Forks Gas & Electric Company which was purchased recently by H. M. Byllesby & Company of Chicago. The principal improvements outlined include the installation of a 750 K.W. engine generator unit, the construction of from 20 to 25 miles of electric pole line distributing system through the residence district, the construction of nearly four miles of new four-inch gas mains, and special inducements to obtain additional consumers of gas and electricity. In the past there has been practically no electric service for residences in Grand Forks.

NEW CATALOGUES AND TRADE PUBLICATIONS.

These catalogues may be had free of charge on application to the firms issuing them. Please mention The Engineering Magazine when you write.

Asphalt Road Beds.

American Asphaltum & Rubber Co., 234 Michigan Ave., Chicago, Ill.—An instructive pamphlet entitled "Good Roads," describing how roads are made dustless, durable, waterproof, and free from mud, ruts, and holes, by the use of "Pioneer" road asphalt, about 236 gallons to the ton.

Automatic Engines.

Skinner Engine Co., Erie, Pa.—A very complete catalogue describing the Skinner engine, and calling attention to the distinguishing features of steam-tight valve economy, practically absolute regulation, automatic oiling and purifying system, and accessibility and reliability.

Electric Hoists.

Sprague Electric Co., 527-531 W. 34th St., New York.—A small catalogue showing very many applications of Sprague electric hoists in a great variety of sizes and designs.

Engines.

Providence Engineering Works, Providence, R. I.—Bulletin No. S-75, most thoroughly illustrated and giving full details of Rice & Sargent Corliss engines. There are included many photographic illustrations of engines installed.

The Russell Engine Co., Masillon, O. —Illustrated catalogue of the Russell single-valve horizontal side-crank "Enclosed" engine. The present pattern is the result of thirty-five years of experience in building this type of engine.

Friction Clutches.

The Hill Clutch Co., Cleveland, O.—Catalogue No. 8 describing in detail the various types of the Hill friction clutch.

Gas Engines.

Turner-Fricke Manufacturing Co., Sharon, Pa.—Catalogue illustrating and describing the Turner-Fricke gasoline engines.

Hoisting Machinery.

C. W. Hunt Co., West New Brighton, N. Y.—General catalogue No. 102, illustrating and describing briefly, but with sufficient information, coal handling and hoisting machinery, conveyors, industrial

railways, electric locomotives, electric and steam hoists, and Manila rope.

WELLMAN-SEAVER-MORGAN CO., Cleveland, O.—A very handsome catalogue illustrating a complete line of hoisting machinery and an interesting equipment shown has the double reel hoist direct connected to a 500 H. P. d. c. motor.

Leather Packings.

DETROIT LEATHER SPECIALTY CO., Beecher and Michigan Aves., Detroit, Mich.—A new catalogue in two colors illustrating leather packings designed for hydraulic presses, hydraulic jacks, hydraulic elevators, hydraulic controlling valves, pneumatic hoists, pneumatic drills, mining machinery and punches, artesian well cylinders, Corliss engines, cotton compressors, etc.

Motors.

SPRAGUE ELECTRIC CO., 527-531 West 34th St., New York City.—Bulletin No. 600, illustrating and describing in much detail single and poly-phase induction motors.

Oil Filters.

BURT MFG. CO., Akron, Ohio.—A very handsomely illustrated descriptive catalogue showing an extensive line of oil filters, exhaust heads, and ventilators. An interesting form is the Burt glass-top ventilator, constituting both a skylight and a ventilator at the same time, in many cases making it unnecessary to provide for any other form of skylight. If the weather conditions make it advisable at times to close the ventilator it may be entirely closed without in any degree obstructing the passage of daylight through it.

Ore Handling Machinery.

THE BROWN HOISTING MACHINERY COMPANY, Cleveland, O.—A catalogue consisting entirely of a number of illustrations of ore and coal handling plants.

Recording Instruments.

BRISTOL CO., Waterbury, Conn.—Booklet of 64 pages, being in the nature of an illustrated index of Bristol's recording instruments for pressure, temperature, and electricity. The book is not in the nature of a catalogue, but simply a series of illustrations of the most important Bristol instruments with partial explanantions of them and their applications. Bulletins cataloguing the various instruments separately have been published and will be furnished on request.

Recording Thermometers.

BRISTOL CO., Waterbury, Conn.—Bulletin No. 124 relating to Bristol recording thermometers. One thermometer shown is for use in residences for continuously recording the outside atmospheric temperature.

Reinforcing.

AMERICAN SYSTEM OF REINFORCING, Chicago, Ill.—Descriptive catalogue of the American system of reinforcing consisting of spirals for columns, frames for girders and beams, and fabric for floors and roofs.

Reinforced Concrete Pipe.

REINFORCED CONCRETE PIPE CO., Jackson, Mich.—Elaborate catalogue illustrating an extensive line of reinforced concrete pipe for sewer construction.

Rib Metal.

TRUSSED CONCRETE STEEL CO., Detroit, Mich.—Descriptive catalogue of rib metal consisting of a series of straight ribs rigidly connected by cross ties formed from the same sheet of steel used in floors, roofs, walls, arches, sewers, etc.

Steam-Turbine Generators.

GENERAL ELECTRIC CO., Schenectady, N. Y.—Attractive publication entitled "Curtis Turbine Installations," containing upward of fifty photographic views of installations of Curtis steam-turbine generators of various capacities.

Steel Belt Pulleys.

THE AMERICAN PULLEY CO., Philadelphia, Pa.—A small catalogue illustrating the American steel split pulley. The mechanical construction is such as to admit of a light rim of one-ply made exceedingly stiff by interior flanges to which the arms are attached, and by heavy rolled beads at the edges of the face.

Tools and Parts.

NATIONAL-ACME MFG. CO., Cleveland, Ohio.—An unusually well arranged catalogue of tools and parts of the Acme automatic multiple spindle screw machine.

Valves and Steam Specialties.

OHIO BRASS CO., Mansfield, Ohio.—Catalogue H, illustrating the Ohio radiator valves, union elbows, globe, angle, and check valves, pressure regulating valves, and steam specialties.

Valve Specialties.

G. M. DAVIS REGULATOR CO., 422 Milwaukee Ave., Chicago, Ill.—Extensive catalogue of valve specialties for power-plants and heating systems.

Water Softener and Purifier.

DODGE MFG. CO., Mishawaka, Ind.—Hangers illustrating the Eureka water softener and purifer, one showing an exterior view and another a sectional view. The latter is illustrated in colors and, besides showing most clearly the action of the apparatus, is an unusually fine specimen of the engraver's art.

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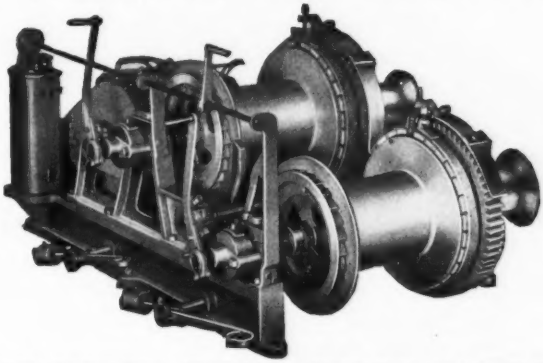
Steam and Electric

Built to meet the requirements of Contractors, Railroads and General Derrick Work



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A SPECIAL FEATURE of our new style double friction drum electric hoist, 15 to 50 H. P., is a pinion between the two drums enabling both drums to revolve in the same direction. This is desirable when it is intended to add boom swinging gear at some future time.

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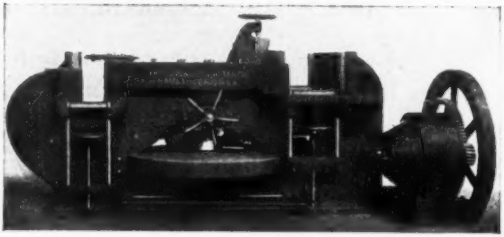

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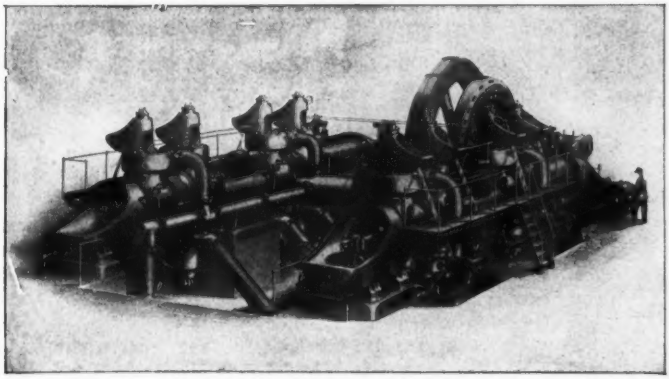

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During a recent inspection of several heavy-capacity units in service in one of the largest steel mills in the country, it developed that the pistons of the engines have never been repaired since installation. One engine, which had been operating a year, was not opened, but is still in daily service. An inspection of one of the power cylinders, after 6000 hours' operation, showed the cylinder surface had taken on a fine polish, and that the tool marks had not been removed by wear. Absolutely no shoulder could be detected at the end of the travel. All the other cylinders were reported to be in the same excellent condition.

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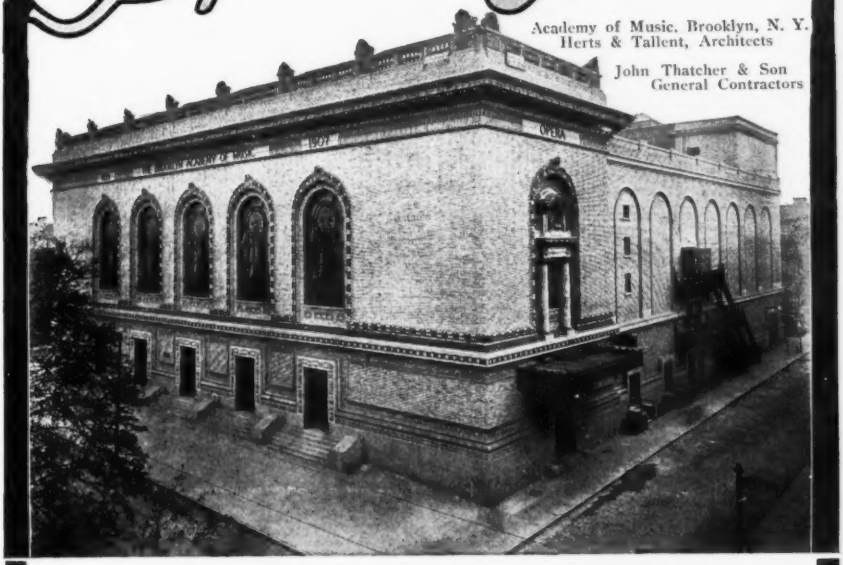

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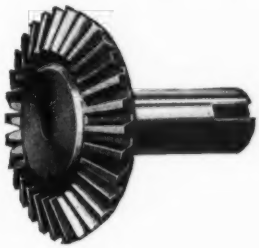

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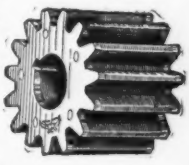

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Mr. Gantt's style is extremely lucid. He takes up the ordinary wage systems, showing logically and clearly why day-work and piece-work fail to promote efficiency. Then he proceeds to discuss "Task-Work with a Bonus" and defines clearly the four elements involved in it—Expert Investigation, Standard Methods, Proper Instructions, Sufficient Compensation. He describes each step necessary in introducing the plan, and everything essential to success in its introduction. Lastly, he shows by example as well as by argument the benefits secured.

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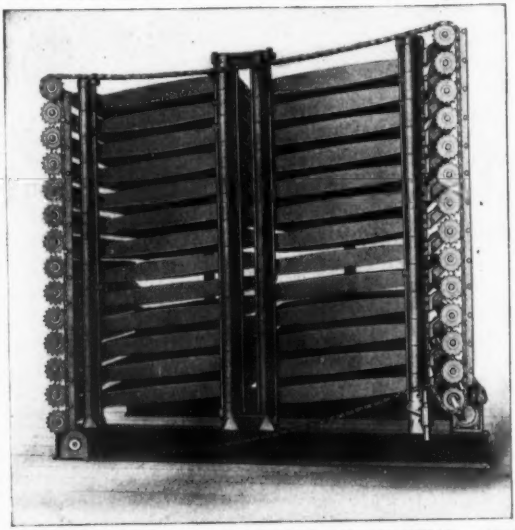
Diamond Chain Replaces Gearing



Formerly the rolls on this cell drier made by Cell Drier Machine Co., Taunton, Mass., were driven by gearing, but this consumed too much power. The trains of gears have been supplanted by a single loop of Diamond roller chain that runs around the machine and engages sprockets on each roll as shown.

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THE PROCEEDINGS OF
THE ENGINEERS' CLUB OF PHILADELPHIA

Edited by the Publication Committee
Published Quarterly in January, April, July, October

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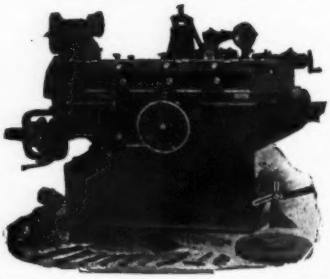

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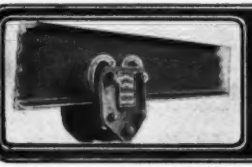

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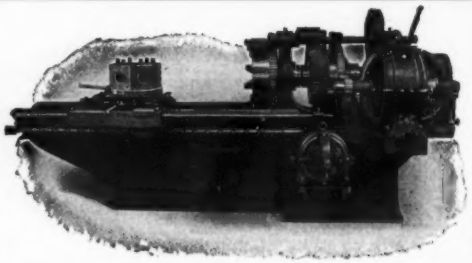

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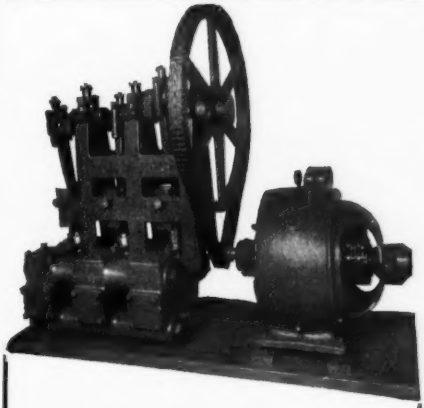

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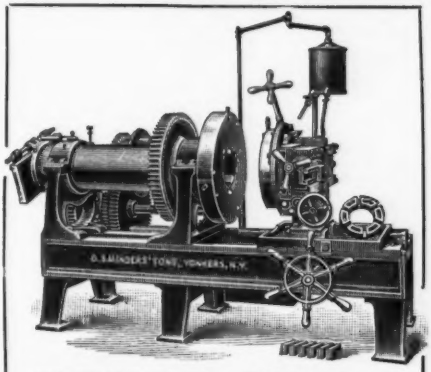

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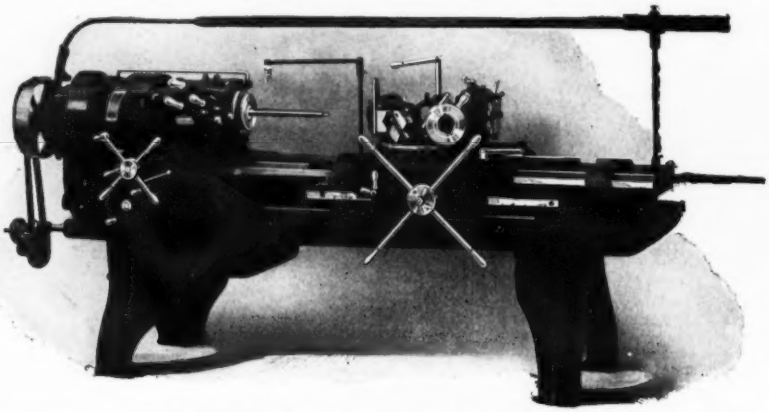

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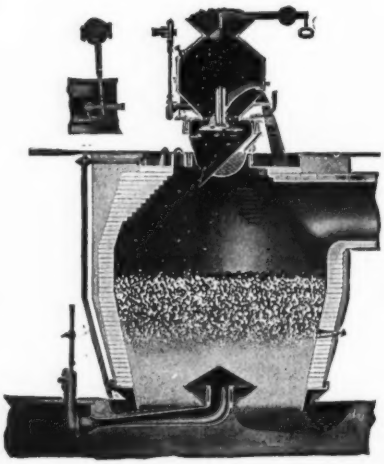

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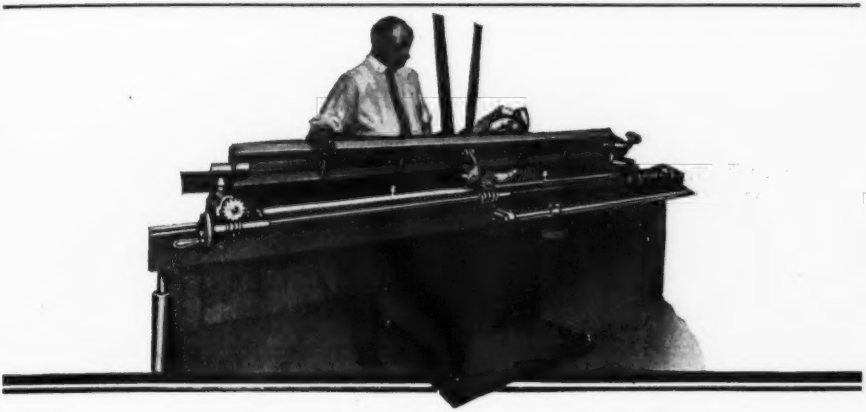

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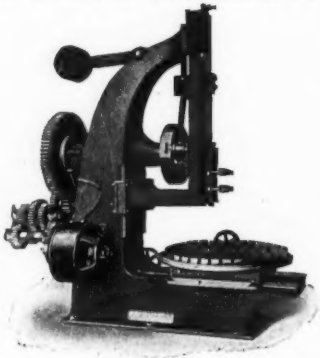

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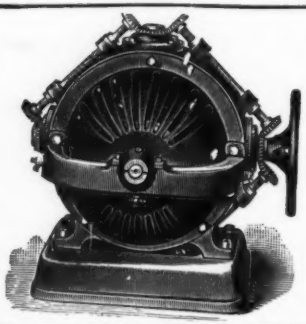

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Only one voltage required to operate.
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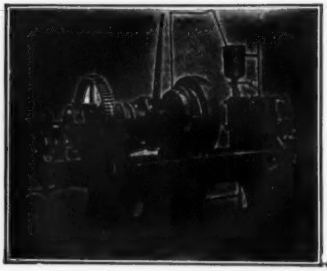

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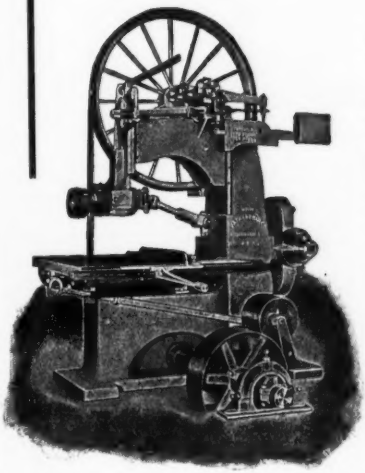

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Cheap machinery has been the downfall of many a firm. The cost of keeping them in order and repairs, very soon outweighs the difference in the cost of first-class tools.

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This is due to the fact that this machine is especially designed for this class of trade, being built for heavy work and plenty of it.

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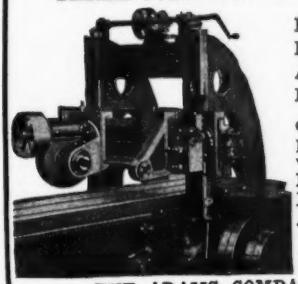

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on any planer with a Farwell Milling Attachment.

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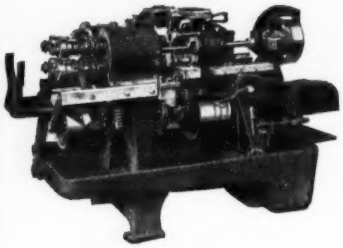
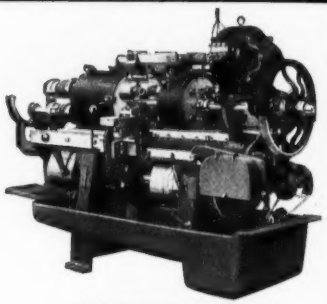


SINGLE BELT



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is an essential part of the equipment of an up-to-date shop. It is fully automatic, finishing the parts in one operation. It is rapid, accurate, and economical.

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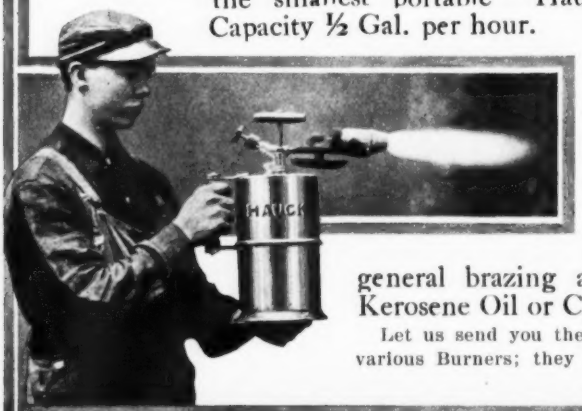

This Kerosene Torch is more suitable for general work and is less dangerous than a gasolene torch.

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A hose that is unrivalled for strength and flexibility—comparatively light in weight—and extraordinarily durable.

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2400 more picks a minute are being obtained by equipping one Loom Driving Pulley.

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Will you try a { Cork Insert Pulley / Cork Insert Clutch / Cork Insert Friction

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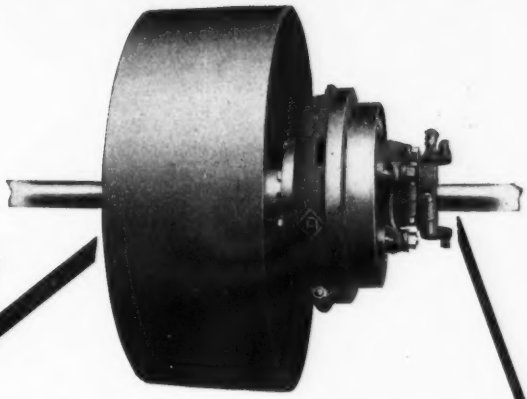

THE Summit Thread Co., East Hampton, Conn., who use the Dodge Split Friction Clutch, recently wrote us—"We have been using one of your clutches for about three years, and while our experience with friction clutches in general has been rather unsatisfactory, the clutch of your make has never caused any trouble whatever." ◈ The Dodge Split Friction Clutch is a real service-giver. It is doing the hardest kind of work in rolling mills, cement mills, rubber mills, mines and smelters and other industries. Some of the largest concerns in these lines have adopted our clutch as their standard, after exhaustive trials and tests of clutches of different makes. ◈ Dodge Clutches are dependable power-savers. Each department, each lineshaft, even each machine throughout your plant may be controlled independently of all the balance of the equipment. Consider the immense saving in power by shutting down idle machines, by having the equipment under instant control in case of accident to men or machinery. ◈ We will be glad to advise with you about Dodge Friction Clutches to exactly meet your requirements. Write us about your possible clutch needs. ◈ Your name on the coupon brings our Clutch Bulletin I-116, which tells about this "economy mechanism." Have us send this book to you at once.

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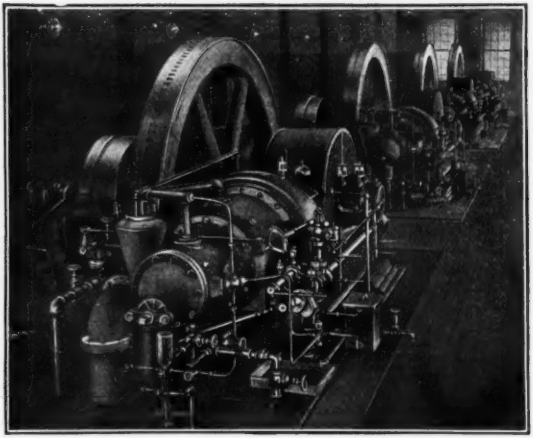

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Most Successful Types
For All Purposes

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Ice Machines.
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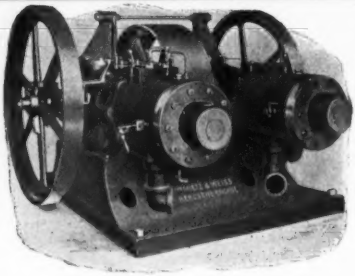

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Operated on Kerosene, Fuel Oil, Crude Oil or Alcohol.

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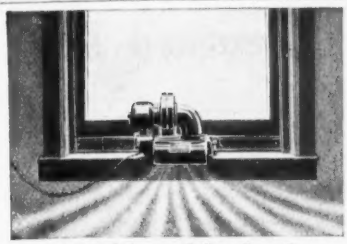

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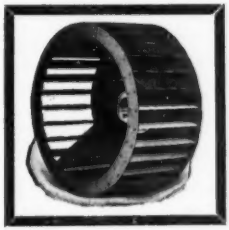

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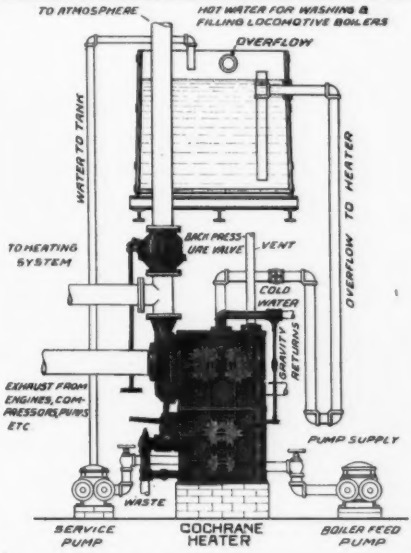


Plenty of hot water for all purposes by utilizing steam in a Cochrane Feed Water Heater.

Each pound of exhaust steam will heat about 6 lbs. of water from 60° F. to 212° F., and the steam itself will be condensed and added to the water, making seven lbs. in all. The **Cochrane Oil Separator** attached to and forming a part of the heater effectually removes the cylinder oil from the exhaust steam, so that the water thus heated is free from oil, and entirely suitable for *washing, dyeing, scouring, boiler feeding, etc.*

If you wish to use part of the steam directly for heating or drying purposes, we can supply our Steam-Stack and Cut-Out Valve Heater and Receiver, which *will save from $50 to $500 on the cost of the equipment,* as compared with any other open heater plus an independent separator for removing oil from the exhaust steam going to the heating or drying system.

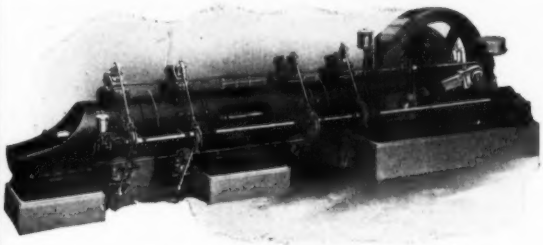
If you are interested, write for a copy of our book on **"The Profitable Utilization of Exhaust Steam."**

Harrison Safety Boiler Works

3138 N. 17TH ST. PHILADELPHIA, PA.

"The American Designed Engine"

THE BUCKEYE FOUR CYCLE GAS ENGINE differs in many respects from the complicated Foreign designs which many American Manufacturers have copied. It is simple in construction, built more on the lines of a steam engine, the working parts are readily accessible, the speed is under close regulation and the igniter system is efficient, all combining to produce reliable service.



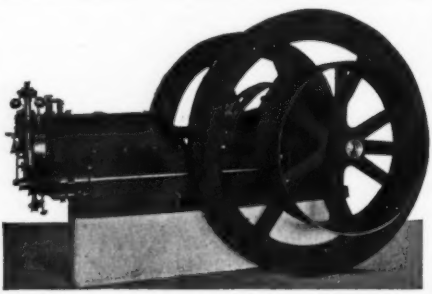
Ask us more about it.

BUCKEYE ENGINE COMPANY

SALEM, OHIO

Fifteen offices in the United States.

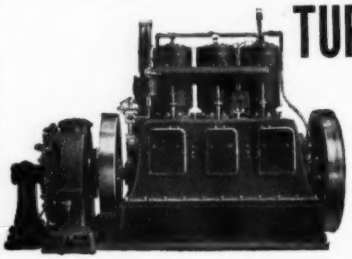
E.M.50



Efficiency, simplicity and durability

all go together to make up the C. & N. Gas and Gasoline Engine. They have all the good qualities of other makes combined with many new features of our own. Sizes ranging from 5 H. P. up to meet your requirements. Prices and full particulars cheerfully given on application.

CLARK & NORTON MFG. CO.
WELLSVILLE, N. Y.



TURNER FRICKE GAS ENGINE

A high grade, close regulating engine.
Operating on natural, illuminating or producer gas.
Absolutely guaranteed in regard to operation, workmanship and material.

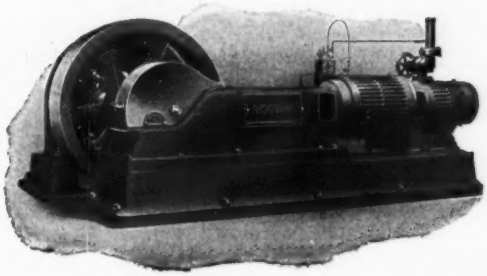
Write for Catalogue.

Agents wanted everywhere.

TURNER FRICKE MFG. COMPANY

Factory, Sharon, Pa. **Main Office, Pittsburg, Pa.**

Please mention The Engineering Magazine when you write.



RIDGWAY UNITS

should be installed where High Steam Economy, High Mechanical and Electrical Efficiency, Close Regulation, Large Overload Capacity, Reliability and Fine Appearance are desired.

Write for Bulletins 19, 20 21 and 24 Y and become better acquainted with RIDGWAY MACHINERY. It will pay you to do so.

RIDGWAY DYNAMO & ENGINE CO.

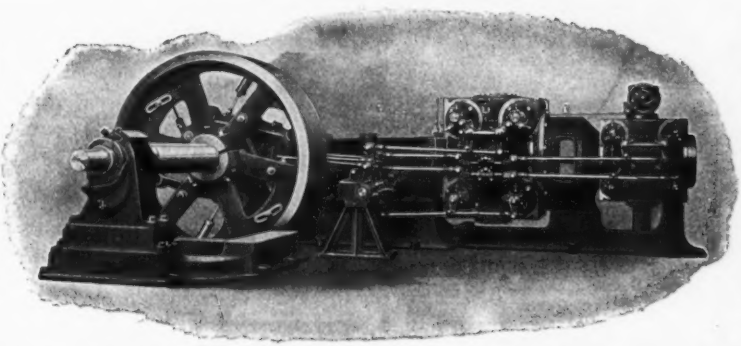
RIDGWAY, PA.

FLEMING-HARRISBURG ENGINES

SIMPLE AND COMPOUND

SINGLE and CORLISS-VALVE

RELIABLE



ECONOMICAL

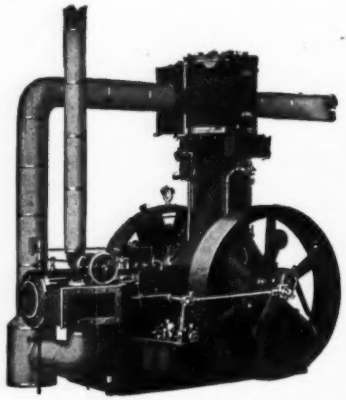
HARRISBURG FOUNDRY and MACHINE WORKS

HARRISBURG, PA., U. S. A.

Power and Light as a By-Product

You have to heat your buildings nine months a year; that means a boiler, coal, coal-handling apparatus and firemen's wages, so why not raise the pressure in the boiler a few pounds and use an **American Ball Angle Compound Engine** for a reducing valve.

It takes high pressure steam, gets enough power out of it to furnish the power and lighting current, and leaves the exhaust steam available for heating purposes.



This engine was designed especially for isolated plants. It has high steam economy, gets twice as much power on the same floor space as simple, cross or tandem compound engines, is perfectly balanced, and runs absolutely noiselessly. As it is compound it can be run condensing in summer and exhaust into the heating system in winter, thus giving the highest possible year 'round economy.

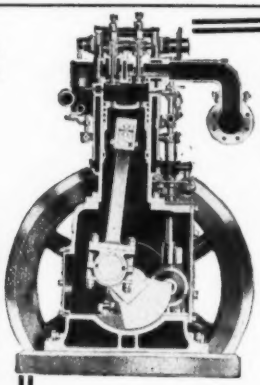
We can refer you to many plants wherein they obtain their lighting current for two cents a K.W. hour, even when not using the steam for heating purposes; if you are paying more than this you are throwing good money away.

Write for our pamphlet, "The Modern Automatic High Speed Engine."

American Engine Co.

43 Raritan Ave., Bound Brook, N. J.

40



Economy in Motive Power

is most surely obtained by the installation of Bruce-Macbeth Gas Engines.

They will develop their full rated horse-power evenly and continuously on a minimum of fuel consumption; and are reliable, safe and positive in operation. They take up very little floor space, and are always accessible for cleaning and adjusting without dismantling. Operates on Natural, Artificial and Producer Gas.

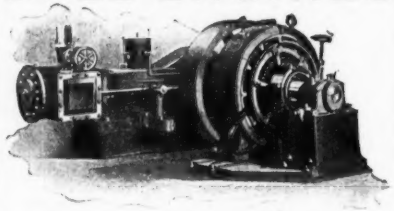
Our Catalogue takes each part separately, and tells how we reduce wear to a minimum and how the complete unit figures effectively in reducing manufacturing costs.

The Bruce-Macbeth Engine Co.

Cleveland, Ohio

2103 Center St., N. W.

BALL ENGINES



We commenced building Engines for Electrical power service in 1882. We have concentrated our efforts towards building the best possible engines ever since. We have the experience, the works and the workmen, and the engineering force to make them right. Our Single-Valve Automatic Engines and High-Speed Corliss Engines with Patented Non-Detaching Valve Gear excel in economy and reliability.

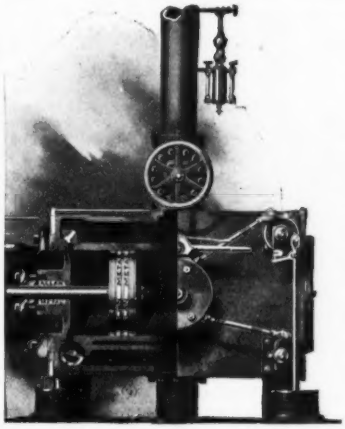
BALL ENGINE CO.

ERIE, PA.

ANTI-CORROSIVE CYLINDER OIL MANUFACTURED ONLY BY E. KELLOGG & SON

WRITE FOR 90 DAY TRIAL PROPOSITION

Trouble in the Cylinder



Excessive friction and wear are by far more expensive wastes in the cylinder than in any other part of the engine. They consume its life's energy directly when it is in its prime.

For years we have claimed, and by thousands of applications of Allan Metal to pistons have proven, that cast iron bull rings working in cast iron cylinders greatly increase friction and wear.

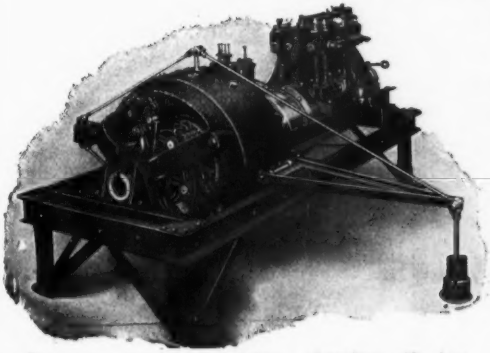
There is but one proper construction for pistons. They should be faced with a metal having excellent antifriction qualities, a melting point sufficient to resist the heat conditions in the cylinder and having a contraction and expansion about equal to cast iron. A metal having these qualities, you will agree, must give better results than cast iron against cast iron.

Our booklet "The Heart of the Engine—The Seat of Power" is a treatise on pistons—Ask for it.

A. Allan & Son, 480 Greenwich St., New York

ENGINE TESTING

MADE EASY



Dynamometer in position, showing 40 h.p. 4-cylinder Gasoline Engine in Test.

Send for a copy of our Bulletin 1087 which gives a simple curve for use with the

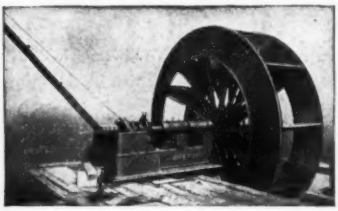
SPRAGUE ELECTRIC DYNAMOMETER

which will give the exact H. P. No difficult calculations. No complicated connections.

It is free for the asking.

Sprague Electric Company

General Offices, 527-531 West 34th St., New York City



The End of the Smoke Nuisance is in Sight.

With a **Green Mechanical Draft Fan** you can burn the cheapest grades of fuel with the highest economy and with the minimum production of smoke. You can have all the draft required under any conditions of load or of atmosphere. You can regulate the amount of air strictly according to the requirements of combustion. You can raise the percentage of CO_2 in the flue gases. You can increase the efficiency of your boilers and economizers. You can apply practically, the modern theories as to driving boilers at high ratings, doubling the steam-producing capacity of a given equipment of boilers, grates and chimneys.

The above picture illustrates a Green Mechanical Draft Fan wheel, 18-ft., 6-in. in diameter, supplied to a street railway company for handling a fluctuating load. This wheel is heavily built and braced and is supported by substantial bearings to insure continuous and reliable operation. It is to be driven by a vertical engine and occupies a comparatively small space, considering the capacity.

Write for our special Book "108-EG" on Mechanical Draft and if you have any problem in hand for the more efficient burning of fuel, submit details so that we may give you an idea of what can be accomplished with the latest methods and apparatus.

THE GREEN FUEL ECONOMIZER CO.

MATTEAWAN, N. Y.

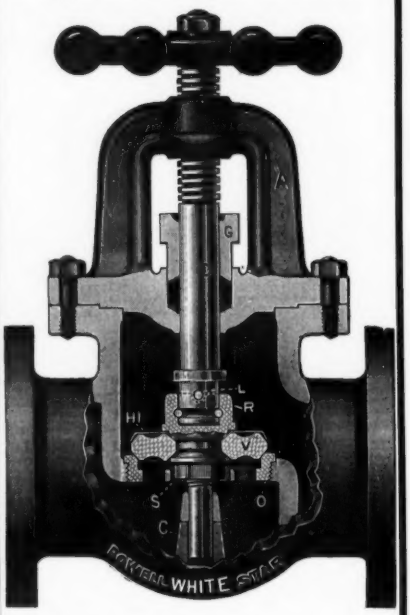
New York City, Boston, Chicago, Atlanta, San Francisco, Los Angeles, Seattle, Salt Lake City, Montreal.

Engineers; Builders of Green's Fuel Economizers, Fans, Blowers and Exhausters, Steam Air Heater Coils, Waste Heat Air Heaters, Mechanical Draft, Heating and Ventilating and Drying Apparatus, Draft Dampers and Engines.

282

THE POWELL

IRON BODY WHITE STAR VALVE FOR Superheated Steam



A strong, compactly built, yet generously proportioned Valve which will stand many temperatures of Superheated Steam.

The DISCS are of solid "Powelium" White Bronze, its melting point 2,000° Fahr., a hard, close-grained mixture that has proven specially adapted to and of long life under steam usage.

The passageway is fully one-third greater than the pipe capacity, reducing friction to the minimum.

The DISCS are REVERSIBLE, and RE-GRINDABLE on both faces, and when completely worn out, REPLACEABLE, thus making the life of the valve independent of the life of the disc.

Pages 74 to 84 of our Catalog fully describe this type. HAVE YOU A COPY?

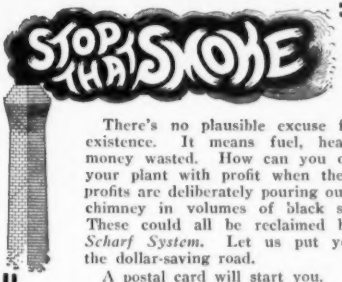
THE WM POWELL CO.

DEPENDABLE ENGINEERING SPECIALTIES

CINCINNATI OHIO

Why install an expensive heating and ventilating system if it is not kept up to its initial standard of efficiency? The **Standard Recording Thermometers** will tell exactly if the system is producing results. Every degree of temperature—during every hour of every day of every week is accurately recorded and comparisons can be made so as to enable an even temperature to be maintained.
Standard Recording Thermometers are necessary adjuncts to the successful operation of every heating and ventilating installation.
Send for printed matter containing sizes, styles and prices.

Standard Thermometer Co.
Boston, Mass.



There's no plausible excuse for its existence. It means fuel, heat and money wasted. How can you operate your plant with profit when the same profits are deliberately pouring out your chimney in volumes of black smoke? These could all be reclaimed by the *Scharf System*. Let us put you on the dollar-saving road.

A postal card will start you.

G.H SCHARF COMPANY, YPSILANTI MICHIGAN
Live Representatives Wanted.

WANTED—Assistant Office Manager by a large company manufacturing telephone apparatus. Man with technical education and some cost, stock record, schedule and general shop system experience preferred. Address Box No. 151, care of The Engineering Magazine, 140-142 Nassau Street, New York.

Consult the Engineering Index in this number.

FUEL STEAM ASH ECONOMY

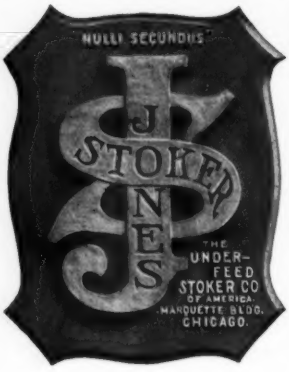
As specialists in the equipment of boiler furnaces for the economic production of steam we can supply **Hand Fired Equipments, Stokers, Coal Distributors** *and* **Pressure Ash Disposal Systems.**

We guarantee
Even Steam
Eliminate Clinker
Correct Faulty Draft
Wide Range of Horse Power

All details in writing contract to be proven before payment is made.

Parson Manufacturing Company

SINGER BUILDING
NEW YORK CITY
Correspondence Solicited.



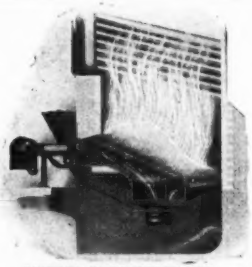
It is said that in every HONEST Bargain BOTH sides gain.

Some years ago an equipment of Jones Underfeed Stokers was installed in a mill in Canada. The purchaser felt that he was paying a rather stiff price for his equipment. A year later the owner of the plant admitted his saving in fuel was 25 to 33½ per cent.—that his stoker was smokeless and had not cost him a cent for repairs.

Some three years later, meeting one of the officers of this company, he said: "I want to tell you I am getting the best of you now. You got a mighty good price for those stokers you sold me, but they've paid for themselves the first year and have paid for themselves *twice* since that time and none of the money I have made by their use in the past two years has gone into your pockets. It has all gone into mine."

We like our customers to feel they are "getting the best of the bargain." There's a whole lot of satisfaction in knowing that your guarantees for economy and efficiency have been exceeded. It's the best kind of proof that our claims are backed up by actual practice.

If you would share in our friend's good fortune and "pocket some money," let us tell you how to do it in the pocket edition of the Jones Stoker Book.



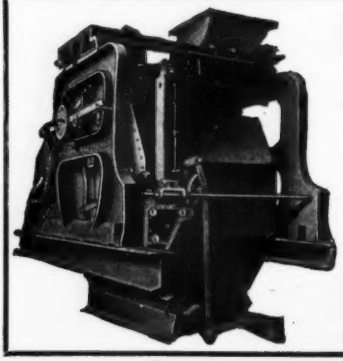
LENHER ENGINEERING CO.
Sole Agents, N. Y., N. J., Pa.
Singer Tower, New York City

TAYLOR STOKERS

By Underfeeding Insure Perfect Combustion
By Gravity Cleaning Save Labor Expense

American Ship Windlass Co.
GENERAL SALES OFFICE AND WORKS
PROVIDENCE, R. I.

15-37



Richardson Improved Coal Scales

For weighing run-of-mine coal from cars or barges.
For checking coal consumption of automatic stokers.
For weighing in coal from the sidewalk.

These machines furnish a perfect check on all coal received at power station, factory, or hotel.

Installed under overhead bunkers, they check the coal consumption of boilers and prevent carelessness in firing.

They will weigh uncrushed and wet coal without stopping.

Many installations—All satisfied.

Richardson Scale Company

4 PARK ROW, NEW YORK, N. Y. 122 MONROE STREET, CHICAGO, ILL.

Don't Breathe Smoke While in PITTSBURGH

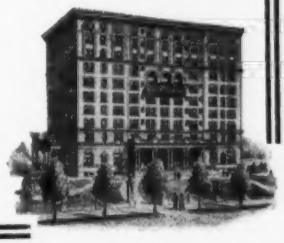
Breathe Pure, Delicious AIR!!!

Get away from the Noise, Smoke and Dirt and yet be within 15 minutes of the Business, Shopping and Theatre Districts. Stop at the

HOTEL SCHENLEY

on the hill opposite Schenley Park and Carnegie Library. Every room an **outside** room. Daylight in every room. European Plan only. Rooms with bath $3.00 and up. Without bath $1.50 and up. If you would enjoy the Freedom of the Club with the Comforts of the Home, get acquainted with

JAMES RILEY, Proprietor.



ACCURATE THERMOMETERS

The world-wide reputation of W. & L. E. Gurley (who now control this business) as makers of instruments of precision, joined with the standing enjoyed by Charles Wilder among the buyers of **accurate** thermometers, will be a sufficient guarantee for the production of thermometers of the highest grade. Special attention given to

Thermometers for Shop and Office Use.

Every article made by us, bearing our name and address, is fully guaranteed. Over 50 years of accuracy is our record.

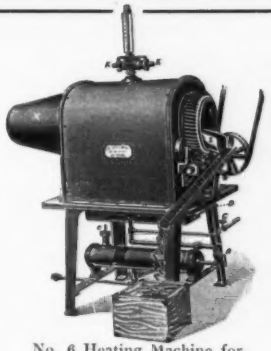
CHARLES WILDER COMPANY TROY N.Y.

The element of chance is entirely eliminated when you use American Gas Furnaces for heating high speed tool steels, or other tools. Because the temperature is **always** under perfect control, the articles do not come in direct contact with the flame; the **live heat** is completely utilized and distributed so as to give best results and least oxidation. Combine these excellent qualities with convenience, cleanliness and uniformity and you have a system that cannot be excelled.

Our Catalogue of Gas Blast Furnaces will point out the road that leads to the **saving** of good hard dollars and the **making of more.**

American Gas Furnace Co.

24 JOHN STREET **NEW YORK**

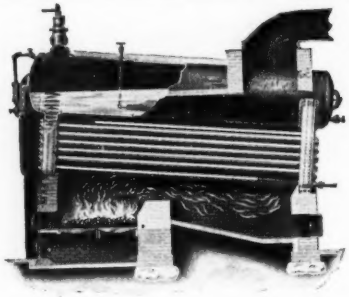


No. 6 Heating Machine for Coloring and Tempering.

WIRELESS TELEGRAPHY

The latest developments in this interesting field are catalogued in

THE ENGINEERING INDEX



FRANKLIN
WATER-TUBE
BOILER

BUILT BY
FRANKLIN BOILER WORKS CO.
TROY, N. Y.
GENERAL SALES OFFICE
39 CORTLANDT STREET, NEW YORK

THE BABCOCK & WILCOX COMPANY
85 LIBERTY STREET, NEW YORK

Water Tube Steam Boilers
STEAM SUPERHEATERS MECHANICAL STOKERS

Works: BARBERTON, OHIO BAYONNE, N. J.

BRANCH OFFICES

BOSTON, 10 Post Office Sq.
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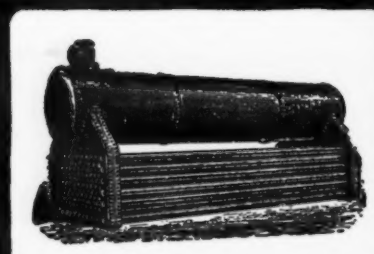
CLEVELAND, New England Bldg.
LOS ANGELES, American Bank Bldg.
PHILADELPHIA, North American Bldg.
NEW ORLEANS, Shubert Arcade
CHICAGO, Marquette Bldg.
PORTLAND, ORE., Wells-Fargo Bldg.
SEATTLE, Mutual Life Bldg.
SAN FRANCISCO, 99 First Street
DENVER, 435 Seventeenth Street
ATLANTA, GA., Candler Bldg.
HAVANA, CUBA, 116½ Calle de la Habana
CINCINNATI, O., Traction Bldg.



HEINE
WATER TUBE
BOILERS

THE ORIGINAL OF THIS ALL STEEL TYPE OF CONSTRUCTION MANUFACTURED ONLY BY THE
HEINE SAFETY BOILER CO. ST. LOUIS, MO. U.S.A.

KITTS REDUCING VALVE

The weighted lever raises the valve disc and allows the steam entering at the inlet to pass at a reduced pressure through the valve and down into the diaphragm chamber. Steam cannot come in contact with the diaphragm as the chamber fills with the condensation and keeps it cool always.

Reduced pressure can be easily changed; valve discs can be removed in a moment. The compound levers make it a sensitive and quick-acting valve, prolong the life of the disc and prevent jumping and hammering.

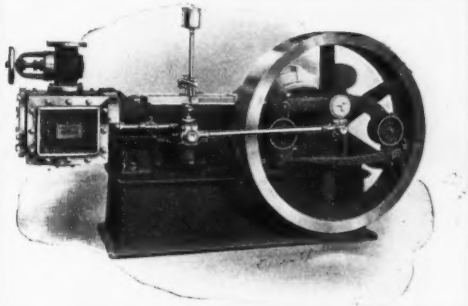
Write for New Catalogue on Reducing Valves, Steam Traps, Damper Regulators, Feed Water Regulators, etc.

Kitts Manufacturing Company
OSWEGO, N. Y.

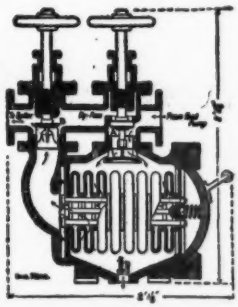
SKINNER ENGINES

FOR HIGH SPEED WORK, THE SKINNER CENTER CRANK ENGINE EXCELS ALL OTHERS. IN THIS TYPE THE ECCENTRIC AND STRAP ARE ELIMINATED, FRICTIONAL SPHERICAL JOINTS BEING SUBSTITUTED.

SKINNER ENGINE CO.
ERIE, PA.
BRANCHES IN 21 CITIES



Keep Out Oil.



The function of this filter is to prevent oil getting into your boilers, and is used wherever a condenser is used.

It is extensively used both on land and sea.

Send for illustrated circular giving details and list of principal users.

ROSS VALVE MFG. CO.
TROY, N. Y.

"Detroit" Improved Standard Lubricators

No matter what price you pay for oil, or how much you use, it will prove a costly investment unless a reliable lubricator is provided for its proper distribution.

The operation of the lubricator must be continuous to produce results.

The Detroit Standard Lubricator "produces results" **economically;** feeding each drop of oil continuously, as needed. No oil wasted. No clogging of the feeding mechanism. The Detroit simply cannot fail to work. Catalogue A-23 will tell why. It will be easy to realize then how **we have sold over a million** and why nine-tenths of the Engine builders in this country specify "Detroit."

DETROIT LUBRICATOR COMPANY
DETROIT, U. S. A.

MOREHEAD
RETURN · NON-RETURN · VACUUM
STEAM TRAPS & BOILER FEED
SEND FOR "TRAP BOOK" Dept-B
MOREHEAD MFG CO. Detroit, Mich.

IT GROWS APACE . . .

The Engineering Index in this Magazine now indexes the engineering journals in Spanish and Italian, as well as in English, French and German. The progressive engineer can no longer get along without it.

DETROIT LEATHER SPECIALTY CO., INC.

EXCLUSIVE MANUFACTURERS

95 BEECHER AVENUE

DETROIT MICHIGAN

HOPPES'

EXHAUST STEAM FEED-WATER HEATERS and PURIFIERS
LIVE STEAM FEED-WATER PURIFIERS
STEAM and OIL SEPARATORS
EXHAUST HEADS

Fully illustrated and described in our

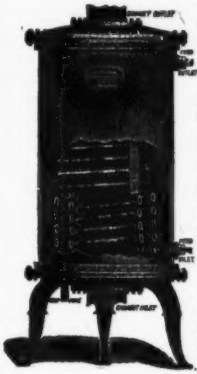
New Catalog No. 40
Want One?

Address

HOPPES MFG. CO.
63 Larch St., Springfield, Ohio.

The National Feed Water Heater

For twenty-five years the great efficiency and entire reliability of **The National** Feed Water Heater have made it the choice of experienced Engineers everywhere. It is the most practical and most economical Heater built; it requires less space and costs less money than any other.



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The "AMERICAN" weighs only two-thirds as much as cast iron pulleys of the same relative size, yet will transmit just as great a load. Just figure into Dollars and Cents what your yearly saving in power alone would be, by not having to turn the excess third.

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THE AMERICAN PULLEY CO.
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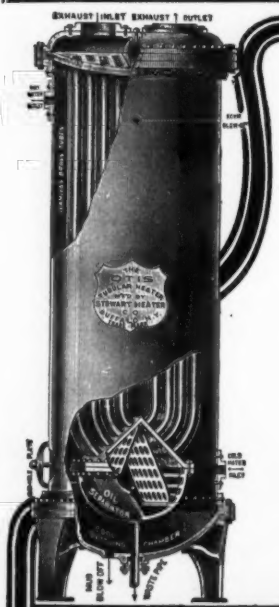

First of all

we guarantee that the OTIS FEED WATER HEATER, OIL SEPARATOR AND PURIFIER can be more easily and thoroughly cleaned than any other Tubular Heater in the market, *and that it will retain its heating qualities when other heaters have become useless.*

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generate a clean, fixed gas absolutely free from tar.

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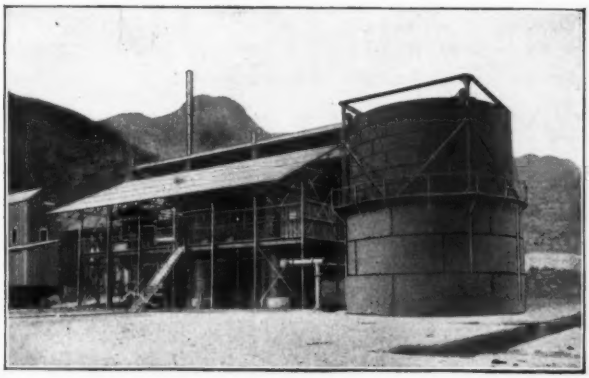

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Patented down draught keeps charging floor cool and free from noxious gases.

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The apparatus is centralized and under one man's control.
There is no steam piping scattered around the building.
Consequently, no danger of freezing or damage from leaky joints, valves or air-cocks.
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Operation is independent of wind or weather.

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It is positive in action, simple, readily adjusted and easily cleaned. It will close the damper promptly to prevent over pressure on the boiler and open it quickly when a hurry call for more steam is made.

This device will save from 10 to 15 per cent of fuel over the old style diaphragm and lever regulator.

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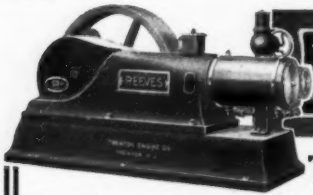

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The Engines That Are Different

The Reeves possesses special merit in three vital points: the Valves, the Governor and the Oiling system. These easily distinguish them from all other makes of engines, and has earned for them the reputation they so justly deserve as being

HIGH CLASS ENGINES

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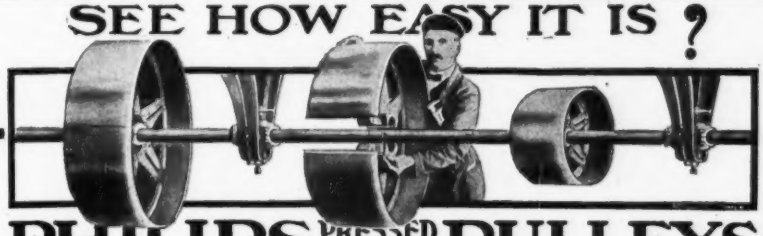

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Can be placed in position in 5 or 10 minutes without disturbing the shaft.

Compare this to time and expense necessary to mount a solid pulley—in stripping everything else from the shaft and replacing again.

Further, consider that there are no set screws or keyways necessary with the Philips.

All you have to do is, have the two halves of the Philips fastened loosely together at one end so as to make a hinge of one of the rim-lugs—separate the halves far enough one from the other to pass over the shaft.

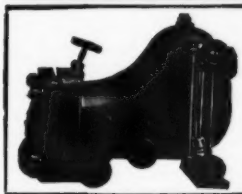
Then, simply get the pulley in line, tighten up the hub bolts, draw rim bolts and you have a satisfactory running pulley.

As we use a cast iron hub, the compression of these four hub bolts gives a grip which makes it impossible for a Philips Pressed Steel Pulley to slip on the shaft.

As we can't tell you more than this one point in this space, please send us your name and address so we can **show you** how the Philips can solve your pulley problem, and send it now before you forget.

Philips Pressed Steel Pulley Works

339 Glenwood Avenue **Philadelphia, Pa.**



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DISCHARGES CONTINUOUSLY AND NEVER BLOWS STEAM.
MADE EXTRA HEAVY FOR HIGH PRESSURE.

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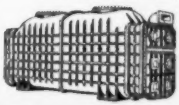

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The Dart Union has *two* bronze metal seats, properly ground, which are *immune* from *corrosion,* and *heavy malleable pipe ends* and *nut.* Nothing more is needed. **Canadian Factory, Dart Union Co., Ltd., Toronto.**

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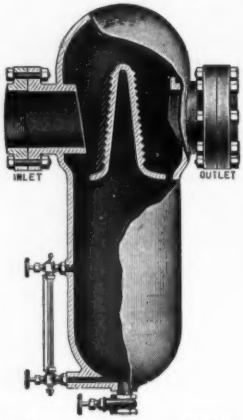

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Steam Separator

takes the water out of the live steam, delivering a current of absolutely DRY STEAM to the engine cylinders, and that's a guarantee of the highest possible service your engine is capable of. You can have it on trial. Write for the Catalog A-17.

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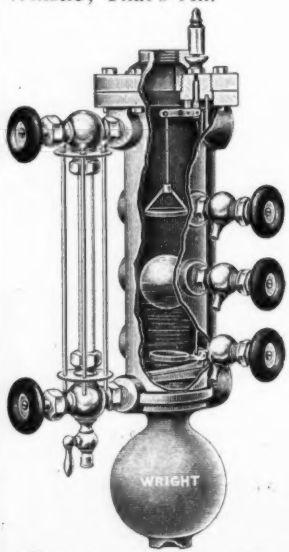

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Try it out under every test. Note its lack of complications compared with some others. If it doesn't satisfy return it at our expense. Write for the Catalog C-60.

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This Heraeus Patented Fused Quartz Glass is not affected by any changes of temperature, whatsoever, and the coefficient of expansion is only 1-17 that of platinum.

It is of the utmost importance for all purposes where the above qualities are essential.

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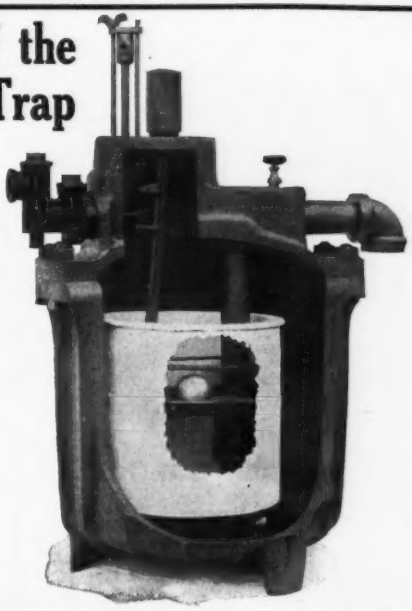
40 Years' Success of the Albany Return Steam Trap



Means 40 years of money saving to power plant operators.

In that time the "Albany" has drained tons of water of condensation from steam lines and returned it to the boilers again and again at temperatures ranging from 212 to 380 degrees without the aid of pumps or steam loops.

The "Albany" owes its success to its simplicity and the correct principles involved in its design.

All steam valves and devices actuating them are enclosed wholly in the trap itself.

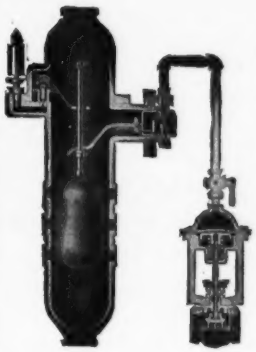
No stuffing boxes to leak or stick.

All joints faced and ground.

Learn how to secure low-priced power by sending for pamphlet A-98.

THE ALBANY STEAM TRAP CO., Albany, N. Y.

WILLIAMS SAFETY FEED WATER REGULATOR.



WILLIAMS SAFETY FEED WATER REGULATOR always reliable; controls the flow of feed water to the boiler, with efficiency and regularity more than human, every one of the 24 hours of the day—every day of the year. It has a service record of eight years continuous use with practically no repairs. That shows of what good stuff the Williams is made. Has no springs, expansion tubes, stuffing-boxes, or rotary valves to become deranged and cause trouble.

Will pay its first cost from two to three times annually. Increases boiler and engine efficiency. Minimizes expansion and contraction, reducing boiler repair bills. Increases boiler steaming space—hence additional power and Dryer Steam in larger quantities. Reduces liability of engine wreckage through wet steam. Reduces boiler-room labor. Saves fuel.

Let us send our booklet telling why 4650 Power Plants are using Williams Regulators.

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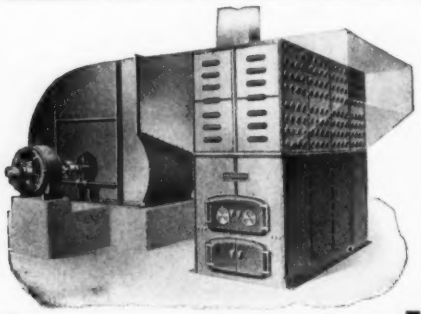

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shows a much higher efficiency than any other type of direct "Fuel-to-Air" heater because the passage of air from the fan is parallel with the heating surface and in a direct line with the distributing ducts. There are no circuitous passages to use up power by impeding the flow.

That the Harrison Aertube Heater is of greater efficiency than a steam system is evident, because no heating boiler can show an efficiency of 80 per cent. and with steam there are losses in coils, piping, pumps, etc.

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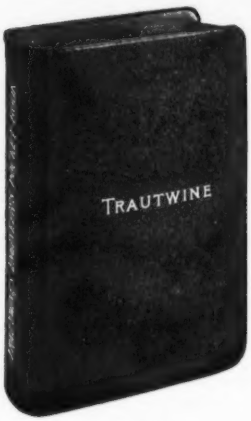

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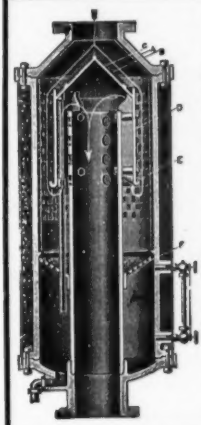

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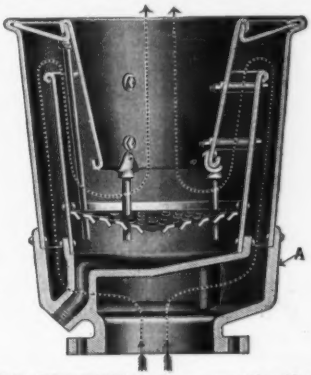

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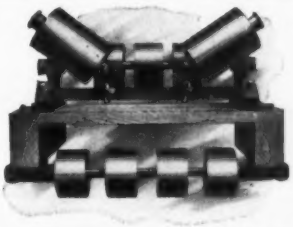

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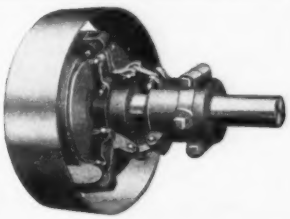

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Orangeburg Fibre Conduit

can be laid practically twice as rapidly as other forms of conduit.

This for two reasons:

First, its extreme lightness makes it unusually easy to handle. *One* helper can easily keep a layer supplied; whereas with multiple clay duct, for example, *two* or *three* helpers would be needed to move the same number of duct feet from curb to ditch. Again, the length of the sections (5 feet) makes it possible for the layer to advance rapidly. For in laying one 5-foot length of Orangeburg Fibre Conduit (weight 6 lbs.) the layer has laid the equivalent of three and one-third lengths of 18-inch single duct clay conduit (weight 45 lbs.). Furthermore, the ease and rapidity with which the joints can be made adds materially to the speed with which the installation can be pushed forward.

THE FIBRE CONDUIT CO. ORANGEBURG PAT. OFF. ORANGEBURG, N.Y.

These and many more points are explained in The Conduit Book. It contains much valuable data on conduit laying in general and will be sent free on request.

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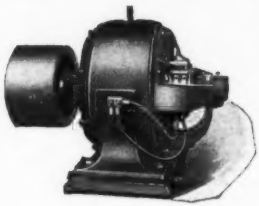

Have an excellent reputation for service. Immunity from breakdown, high efficiency and low temperature rise are their noteworthy features.

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is to install a type B limit switch on the trolley.

A type B limit switch is a safety device that breaks the motor circuit the instant that the safe limit of travel has been reached.

A great many wrecks have been averted through their extensive use, just as they will avert wrecks for you if you give them a trial.

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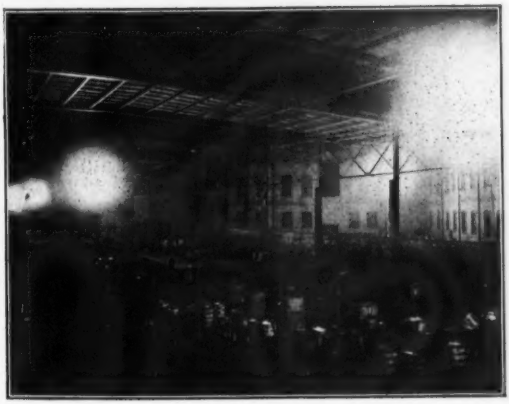
For Factory Illumination



One lamp will replace from three to five carbon arcs and give you better illumination with a corresponding saving in current consumption.

Maintenance and operating costs very low, owing to latest reduction in price of carbons.

Do not delay, write for bulletin today.

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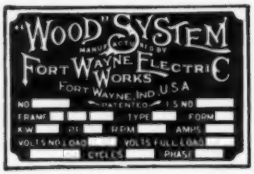
CLEVELAND, OHIO

New York Office, 40 Wall Street. **Pittsburg Office, 910 Liberty Street.** **Chicago Office, 303 Dearborn Street.** **Philadelphia Office, 318 Land Title Building.**

Our Nameplate On A Generator

is worth more than the best guarantee ever written. A guarantee protects you for a short time only, but our name on a machine is assurance of its continuous satisfaction.

Before we attach the nameplate every machine has to pass tests much more severe than it will encounter in actual service. That's why our generators take up their work without a hitch right from the start.



They continue year after year to give satisfaction because we have never slighted the material or workmanship.

Some manufacturers as soon as they get a suitable designed machine try to see how much they can cheapen its construction without effecting its performance "very much."

This disregard of quality may not show up for some time, but if your machine goes to pieces soon after the contract expires--well you lose.

There's one sure way to get the quality you hope to get in the generator you buy--look for our nameplate on it.

We have several Bulletins giving details of our various types and sizes, that we will be glad to send you.

FORT WAYNE ELECTRIC WORKS
"Wood Systems"
1630 Broadway, Fort Wayne, Ind.
Branch Offices Most Large Cities.
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TUBULAR POLES
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SIMPLEX QUALITY

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FOR SALE.—Engineering Magazine, Vols. 1 and 2, Leather Bound Vol.; 3, 4 and 5, Cloth Bound. Unbound Vol. 6, except Dec. 93; Vol. 7, except April 94; Vol. 8 complete, one copy each, April and June, '95. Address Box 152, Care of The Engineering Magazine, 140-142 Nassau Street, New York.

CONSULT THE

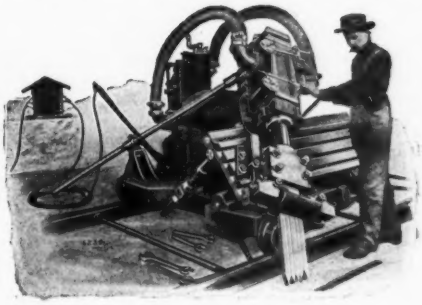
ENGINEERING INDEX

IN THIS ISSUE.

INGERSOLL-RAND CO.

NEW YORK LONDON

"ELECTRIC-AIR" CHANNELERS



We have just issued a new pamphlet, No. 6102, on the "Electric-Air" Channeler, which will tell you much more about it than we can attempt here.

We want your name, so we can send it to you. Here we will merely emphasize a few points.

Economy—With the "Electric-Air" Channeler you will get all the capacity of the standard steam or air channeler, **with a saving of at least half the power.**

Capacity—Its blow is of a tremendously effective quality, and great penetrating effect.

Simplicity—No machine approaching it in its capabilities has so little about it to get out of order or cause trouble.

Endurance—This remarkable simplicity, together with the heavy construction, makes repairs a very small item on this machine.

Adjustability—There is a remarkable flexibility to this channeler, adapting it to a wide variety of operating conditions.

Here you have, in the "Electric-Air" Channeler, every good feature you ever heard of and some exclusive advantages as well.

A few of these machines, supplemented by an equipment of "Electric-Air" Drills, will enable you to have an "electric quarry" throughout, without sacrificing the advantages which you associate with the use of compressed air.

For both of these devices are **air** machines, driven by an electric motor.

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AIR COMPRESSORS
ROCK DRILLS
HAMMER DRILLS
ELECTRIC-AIR DRILLS
STONE CHANNELERS
CORE DRILLS
COAL CUTTERS
PNEUMATIC TOOLS
PNEUMATIC HOISTS
PNEUMATIC PUMPS

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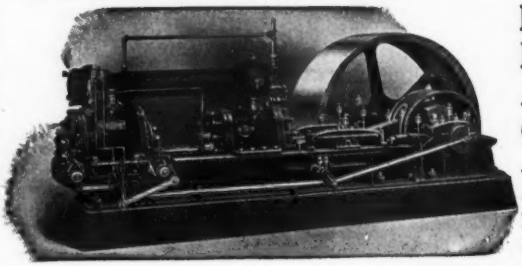
Budapest, Dusseldorf, Johannesburg, Kobe, London, Melbourne, Mexico, Montreal, Paris, Yokohama

THE NORWALK IRON WORKS CO.
SOUTH NORWALK, CONN.



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with Automatic Selective Proportional Unloaders.

Distinctive Engineering Advance. Radical Mechanical Improvement.

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Capacity-Eight cars per day

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COLLIER POWDERS, - by the Sinnamahoning Factory

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Made in all grades to meet any requirement in gaseous and dusty mines and for any kind of coal.

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ALL OF OUR PRODUCTS ARE GUARANTEED

Write us and we will send you the official record made by over Eleven Million Pounds of Dynamite furnished by us to the United States Government for the Isthmus of Panama last year, surpassing all previous records in efficiency. Present contract with the Isthmus of Panama, Four Million Six Hundred Thousand Pounds.

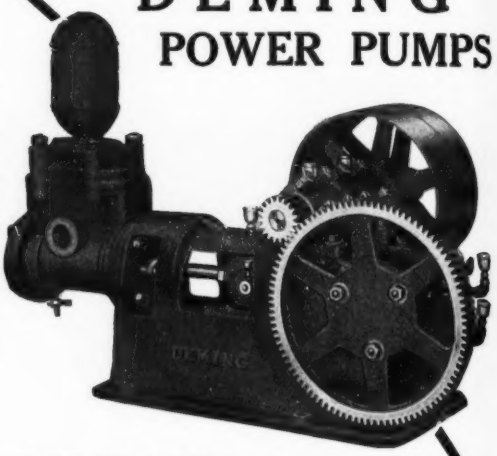
General Service Pumps

The horizontal Double Acting Power Pump shown in illustration is adapted for feeding boilers, tank service, irrigating and general water supply. Built for continuous and lasting service.

Our Power Pump Catalogue contains complete information of our entire line of triplex and other power pumps for operation by any power.

Send for it.

DEMING POWER PUMPS



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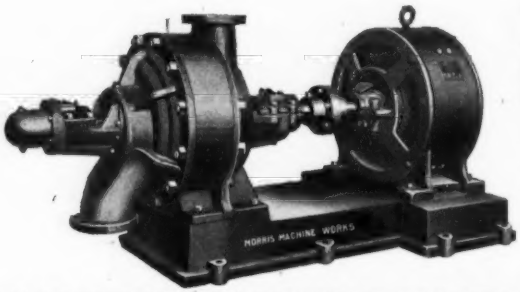
HENION & HUBBELL, General Western Agents, Chicago, Ill.
Other Agencies in All Principal Cities.



Electric Pumps

Centrifugal pumps are peculiarly adapted to electric drive on account of their high speed. We build them from ¾" to 48" discharge.

Send for our 1910 Catalogue on Centrifugal Pumps.

MORRIS MACHINE WORKS, Baldwinsville, N.Y.

39 & 41 Cortlandt St., New York. Charlotte, N. C. Houston, Texas.

ESTABLISHED 1828 — **I. P. MORRIS COMPANY** — INCORPORATED 1876

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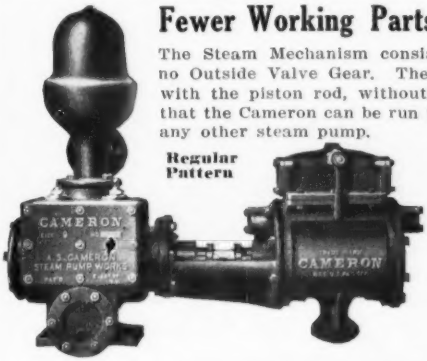
STEAM AND HYDRAULIC TURBINES OF SPECIAL DESIGN
CENTRIFUGAL PUMPING MACHINERY
SPECIAL HEAVY MACHINERY
LAND AND MARINE BOILERS. BRASS AND BRONZE CASTINGS
IRON CASTINGS UP TO 50 TONS

The Slogan of the Cameron—"Character: The Grandest Thing"

CAMERON PUMPS

are as reliable and efficient as 50 years' experience can make them. They are in use for years and years under conditions that would knock the "cheap varieties" out in no time, and their repairs are reduced to the minimum.



Regular Pattern

Fewer Working Parts than any other Steam Pump

The Steam Mechanism consists of four stout pieces only. There's no Outside Valve Gear. The Steam Valve movement works in line with the piston rod, without the intervention of arms or levers, so that the Cameron can be run faster, without danger of breaking, than any other steam pump.

"I have had considerable experience with your pumps. Have always found them reliable and cost little for repairs. For all kinds of work I regard your pump as the best on the market, principally on account of its RELIABILITY.

"L. C. Wyman, Supt.,
"Huizopa, Chih., Mexico."

New Cameron Catalog Editon "X" illustrates and describes all types of Cameron Pumps. Sent on request to interested pump users and intending purchasers.

A. S. CAMERON STEAM PUMP WORKS

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$125

were saved by one user of THE ENGINEERING INDEX in one order. Does it save you money too?

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Over 70 sizes and styles, for drilling either deep or shallow wells in any kind of soil or rock. Mounted on wheels or on sills. With engines or horse powers. Strong, simple and durable. Any mechanic can operate them easily. Send for catalog.

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PUMPS

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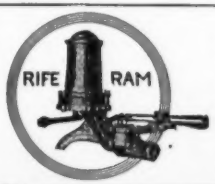
SIMPLE COMPOUND & COMPOUND CONDENSING ELEVATOR & WATER WORKS PUMPING ENGINES



A RUNNING WATER SUPPLY PLANT

that takes care of itself—furnishes its own power—requires no attention or repairs—that is what you get in a

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Raises water **30 feet for every foot of fall** from any nearby stream, spring or pond. Any capacity for all home and farm uses, **Irrigation, Town Plants, Railroad Tanks,** Etc. Low in cost, high in efficiency.

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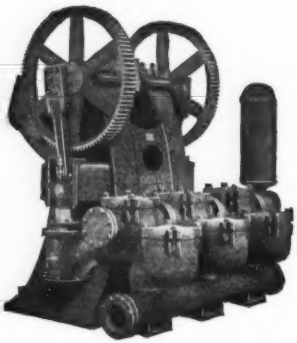
PUMPING PROBLEMS



Do you know that you can meet your pumping problem with GOULD'S EFFICIENT TRIPLEX POWER PUMPS more economically than by any other method?

Their great saving demonstrated in factories, mills and modern buildings is acknowledged by Engineers. Install a Power Pump and drive it by belt from line shaft, engine or electric motor or direct connected to any power, and it will prove to you their great economy.

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Either flanged or bolted joints. From 3 to 30 inches diameter galvanized or asphalted
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PUMPS OF BOTH
VOLUTE AND
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FOR EVERY SERVICE

ALBERGER PUMP COMPANY

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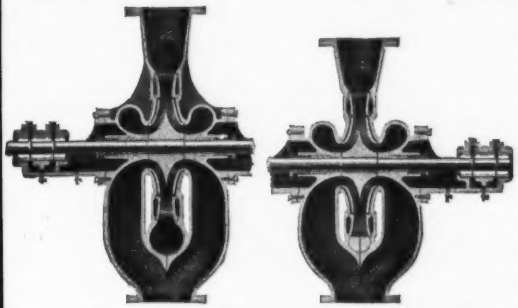
A Smaller Pump for the Same Capacity



These two cuts, made to scale, show the difference in size between an ordinary turbine pump with concentric waterways and a *WATSON - STILLMAN TWINVOLUTE PUMP.* of the same duty. There is also a power saving which makes the efficiency higher with the Watson-Stillman.

The weight of the pump is decreased and this means smaller floor space as well as decreased pump and foundation costs.

Furthermore, the center of gravity of a twinvolute pump is lowered and the vibration reduced. This means longer life for the pump and an absence of noise, which with other types may be troublesome.

Tell us the conditions under which you wish a pump to operate.

Ask for Catalogue 75.

THE WATSON-STILLMAN COMPANY

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29

ELECTRICAL ENGINEERING

CONSULT the Engineering Index in this Magazine for numerous valuable papers on Electrical Engineering. For the convenience of card-index users who wish to preserve indexed items, in card-index form, The Engineering Index is issued separately from the Magazine, printed on one side of the paper.

Ask for specimen

THE ENGINEERING MAGAZINE

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THE PHOENIX "LITTLE GIANT" will give as **great a percentage** of power at full gate as **any wheel** made.
It will also give **a greater percentage of power at one-half gate than any other wheel** in the market.
The gate is **always tight** and **never** out of order.
Has a strong, steady and regular movement, starts easily and is easy to regulate, simple in construction—will not choke readily, no skilled mechanics required to keep it in efficient working order. Read our booklet and you will understand why we call our wheel "Little Giant."

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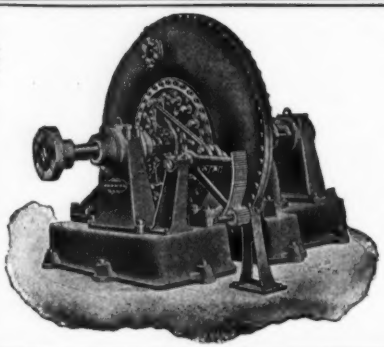

Francis and McCormick

TURBINES

Francis Horizontal Shaft Turbines of 43,000 Horsepower are now being built, to operate Six (6) generators for the Great Falls Townsite & Water Power Company, Great Falls, Mont.

Water power plants for **High and Low** heads designed and estimates supplied by

S. MORGAN SMITH CO., York, Pa.
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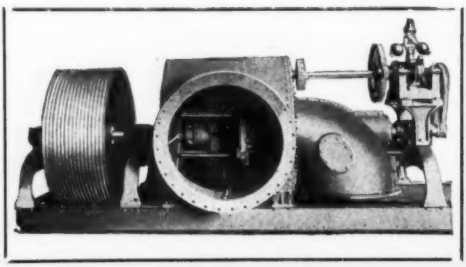
176 Federal Street, Boston, Mass.

SAMSON WATER TURBINE



The higher the SPEED of a GENERATOR the LOWER its COST. We can SAVE YOU MONEY if you will use the SAMSON to drive the generator because there is not another turbine built that will attain as quick a SPEED when operating under the same conditions.

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THE ORIGINAL McCORMICK TURBINE

Built by the same reliable concern that made the first "McCormick Holyoke" Turbine.
If you have a proposition for anything up to 100-foot head, send us your specifications. We can build a wheel to meet your requirments if anyone can. Our catalog contains official tests and power tables invaluable to water power users. Sent gratis.

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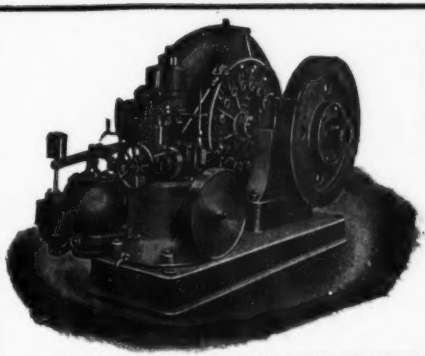

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High Efficiency and Satisfactory Regulation
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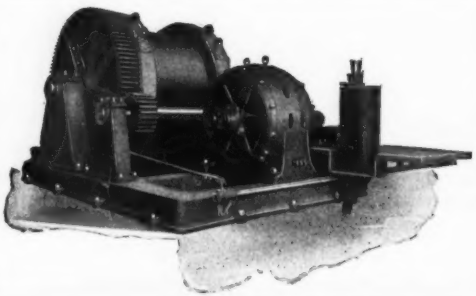

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Suited for Contractors, Pile Driving, Quarry and Mine Duty,

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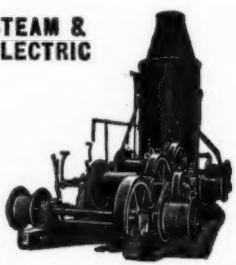

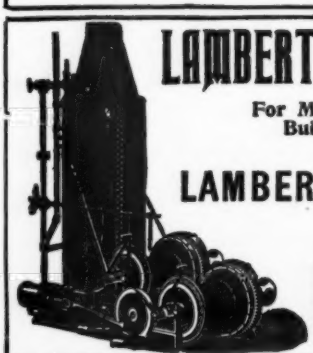

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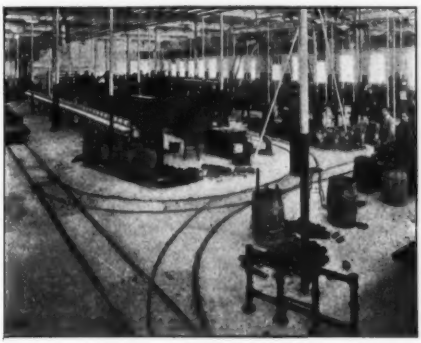

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It will increase the output of works or of factory at the same expense.

Simple to install, as an ordinary workman can lay it down.

One company installed this system and their payroll was reduced $24 per day and in addition the capacity was increased.

The flexibility of the railway makes every corner accessible.

The gauge is 21½ inches and can be laid within the standard tracks without cutting the rails. The track is made up in four styles:

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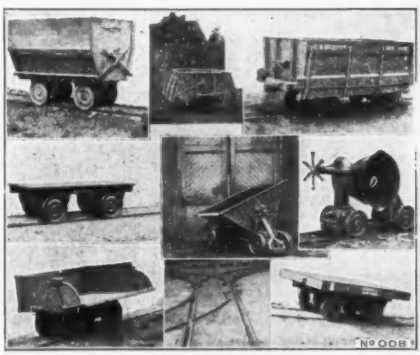
Everything for use with this system is kept in stock for immediate delivery.

If the necessary data is sent, we will prepare a lay-out without charge and with the right cars will show where this saving can be effected.



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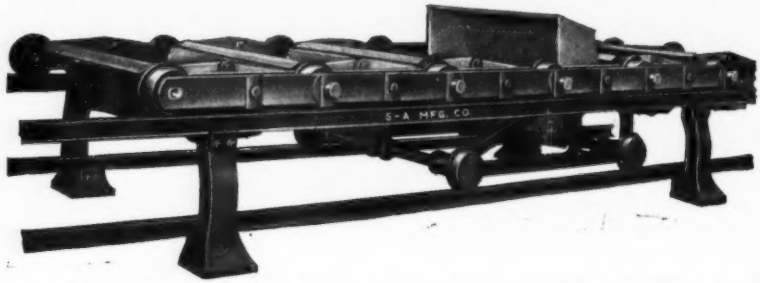

These carriers will convey, elevate and store heavy materials at a very low cost per ton. We issue the best catalog of conveying machinery that was ever published and will send one by prepaid express to those interested in modern labor-saving machinery.

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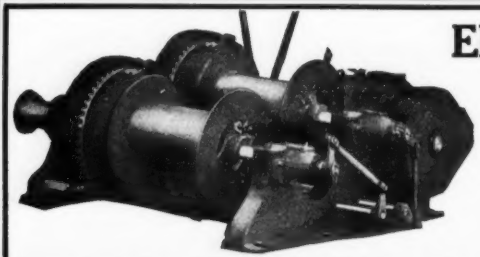

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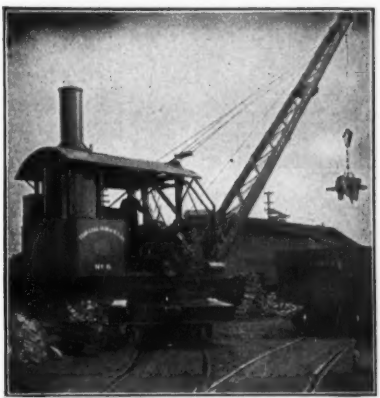

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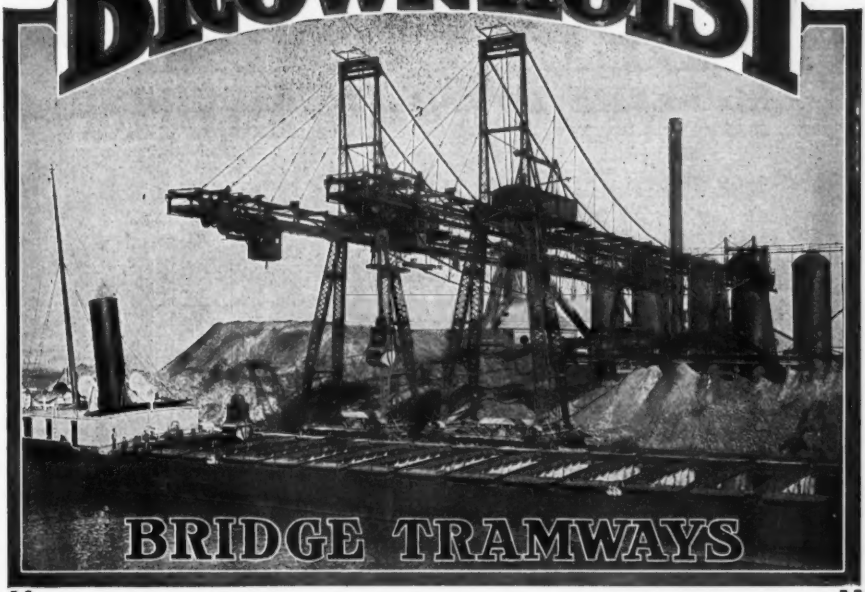

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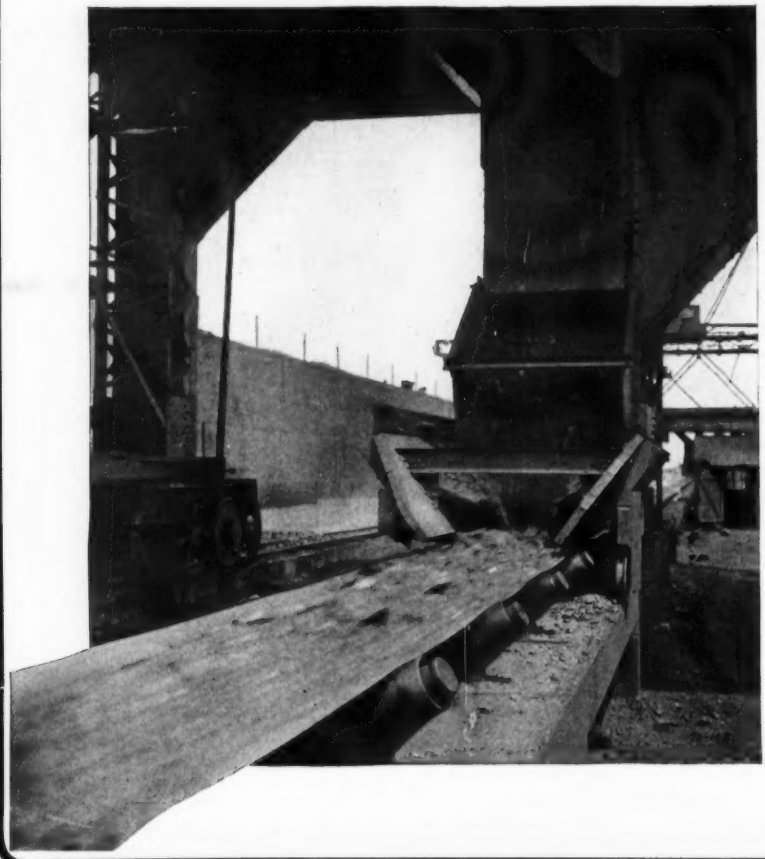

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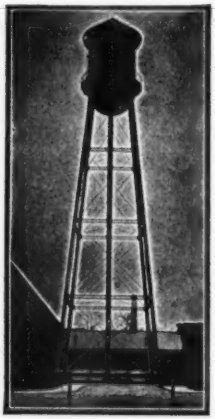

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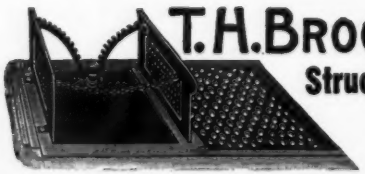

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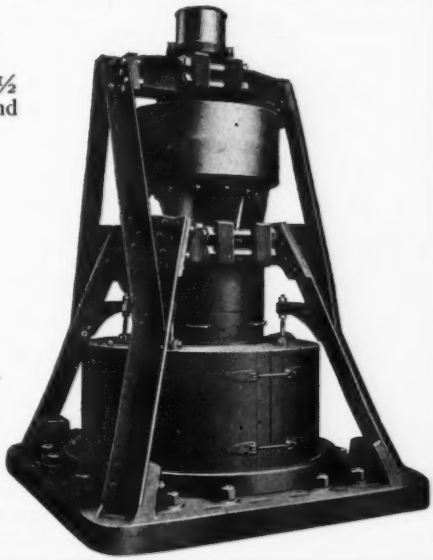

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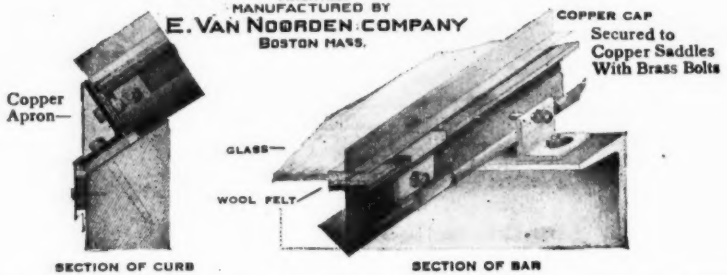

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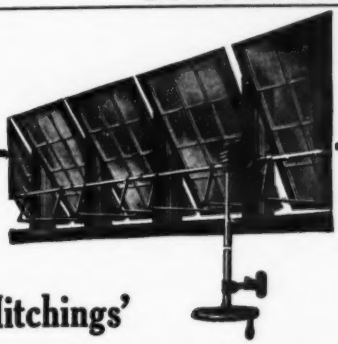

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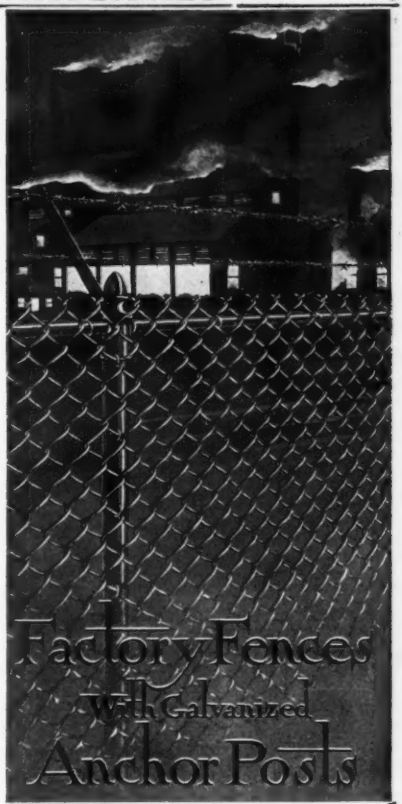

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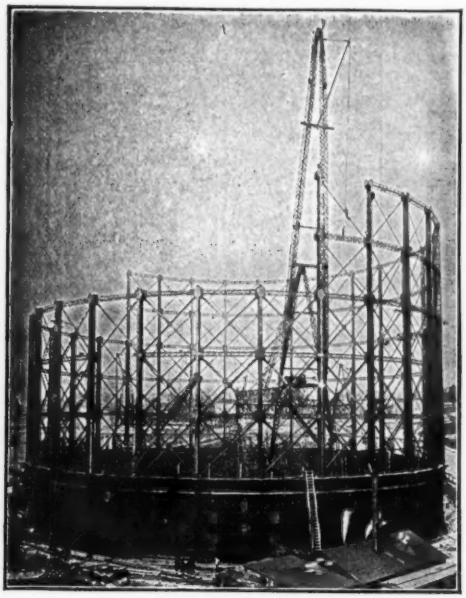

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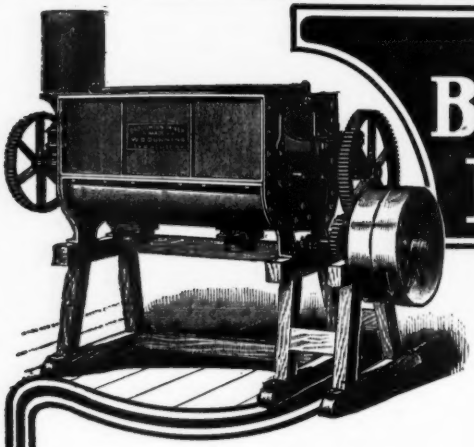

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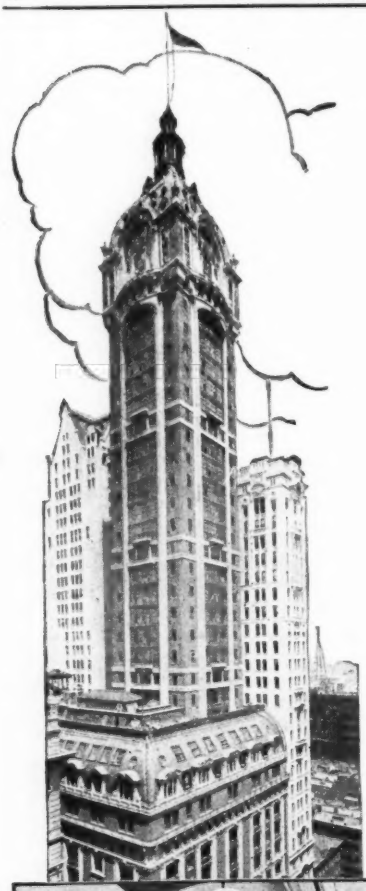

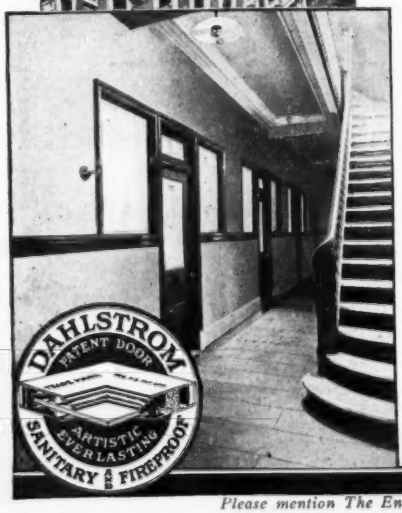

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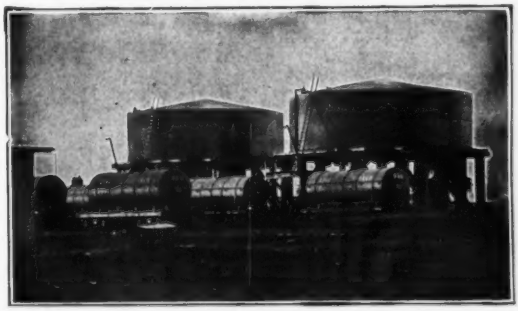

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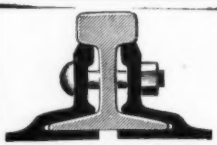

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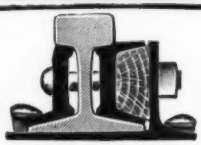

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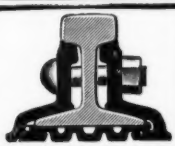

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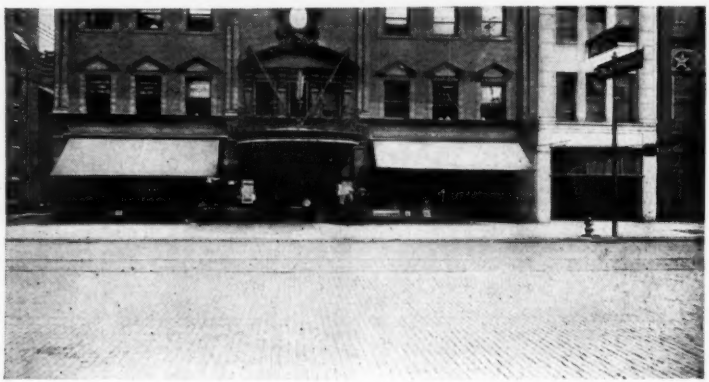

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The following is a paragraph from a paper presented at the annual meeting of the Iowa Street Railway Association at Sioux City last April, by W. A. Heindle, Superintendent Construction of the Tri-City Railway, Davenport, Iowa.

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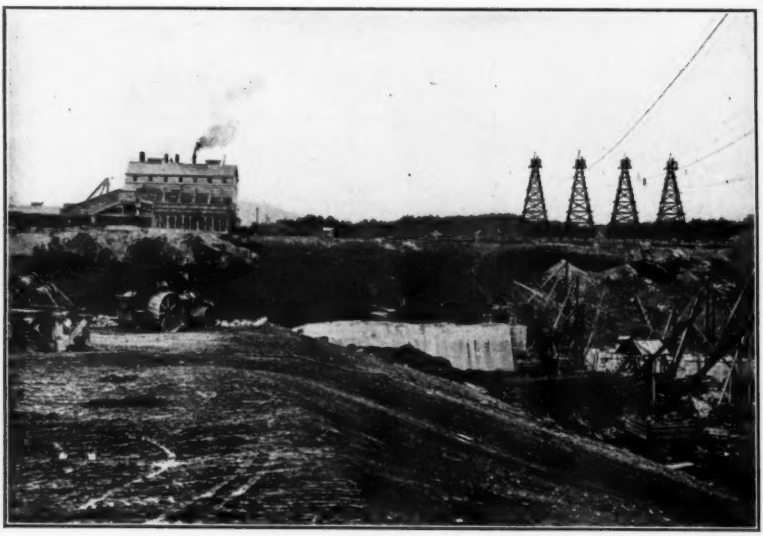

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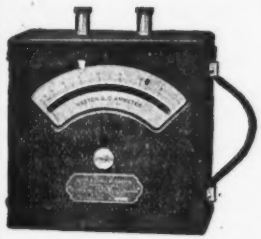

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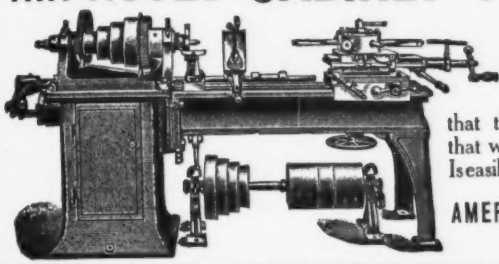

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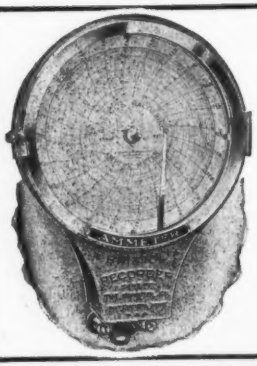

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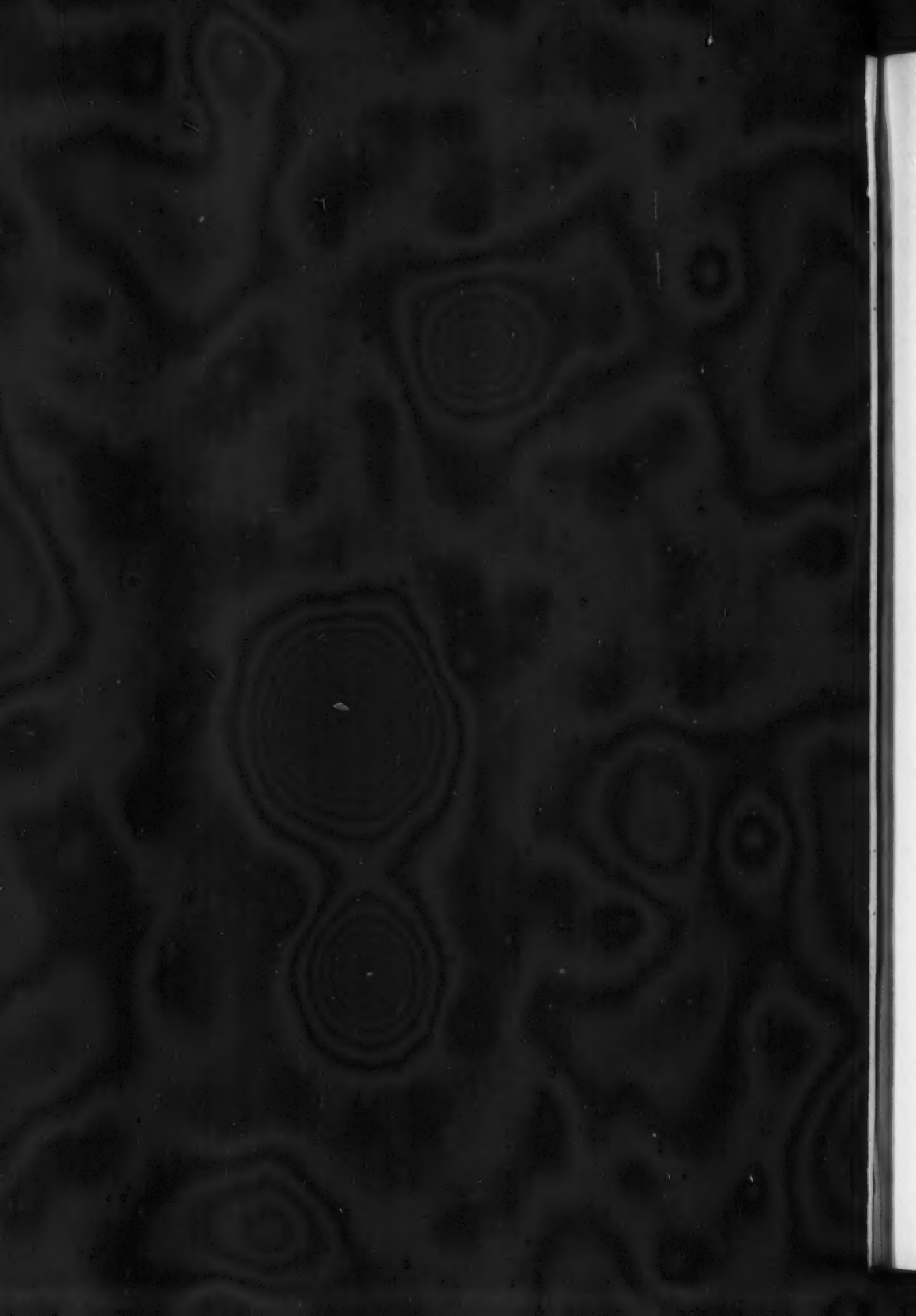

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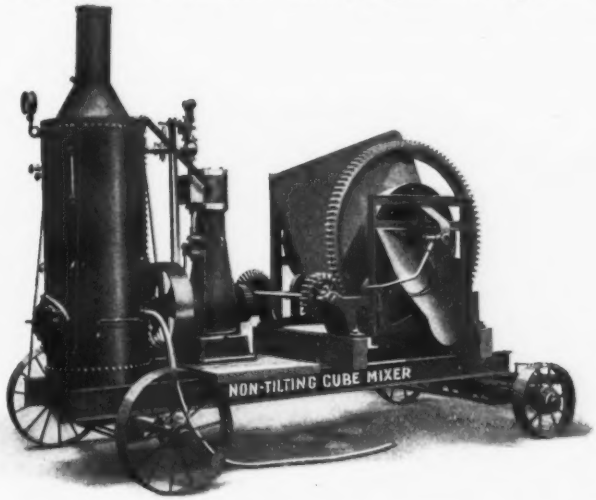
Mixing Concrete.

THE interest aroused among our readers by Mr. Sloan's suggestive and very excellent papers on the "Industrial Applications of Reinforced Concrete" prompts us to draw attention to the remarkable advance that has been achieved in recent years in the design of machinery for mixing concrete materials. Everybody is impressed with the enormous increase in the use of concrete in the building industries, but comparatively few seem to appreciate that in many branches of engineering work the application of concrete is also very rapidly and steadily increasing. This in turn has created a demand for improved machinery, and it is in engineering work, especially, that the Austin Cube Mixer has been winning significant recognition in recent years. On the Panama Canal twenty of these machines, of the largest capacity ever built are now in use; twenty-two railroad companies in the United States alone have introduced them, and foreign governments, large contracting firms and engineers generally are appreciating the principles involved in the design of this machine.



In the accompanying illustration we show this mixer placed on trucks, with steam engine and boiler, presenting the discharge side. The point of special merit in the machine consists in the fact that the mixer is a square steel box, with two diagonally opposite corners cut off very short, and it is so arranged mechanically that in revolving it effects a thorough kneading of the pasty mate-

rial, which is the all-important point. Describing the machine and process, the builders say:

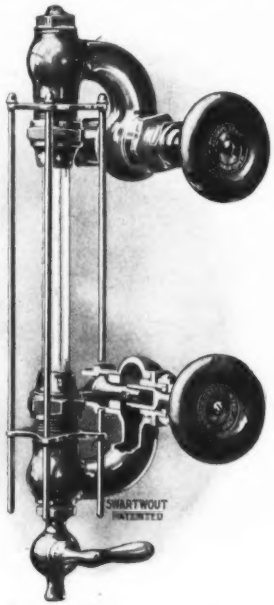
"There are no small blades inside the Austin Cube Mixer to do the mixing. Three discharging vanes, which are so large that there is no tendency for the cement to clog, constitute the entire mechanism. The batch is charged into the mixer in a unit mass and thoroughly mixed as a unit by folding and refolding the batch over upon itself six times in every revolution. Deflectors, blades or shelves are not necessary to mixing in a Cube Mixer. The grinding and kneading action of a cubical-shaped mixing drum is the only process that positively grinds away the film of fine dust on the surface of crushed stone or the coating of loam from gravel, thereby automatically preparing same so it can be pressed and rubbed into absolute contact with the cement paste. Austin Cube Mixers produce a quality of concrete as perfect as it is possible to make it and more perfect than is possible by any other system known. It is the most rapid mixer ever built. It does not tilt to discharge its batch. It has a low charging level and a high discharge. It is simple in construction and every part is interchangeable."

The makers have recently issued an illustrated booklet, No. 50, giving complete details as to the construction and operation of the machine, and this they will be pleased to send upon application. Address the Austin Cube Mixer Company, 644 Railway Exchange Building, Chicago, U. S. A.

Swartwout Water Gauge and Gauge Cock.

THE well-known disadvantages of the usual form of gauge glass are lack of durability and the frequency with which it breaks, endangering the eyesight of the boiler attendant, allowing the water to escape from the boiler to a dangerously low level, and the difficulty and danger of replacing the glass while the boiler is under pressure. To eliminate these difficulties new and ingenious devices have been incorporated in the Swartwout automatic safety water gauge made by the Ohio Blower Co., and a similar design applied to the mechanism of the gauge cock.

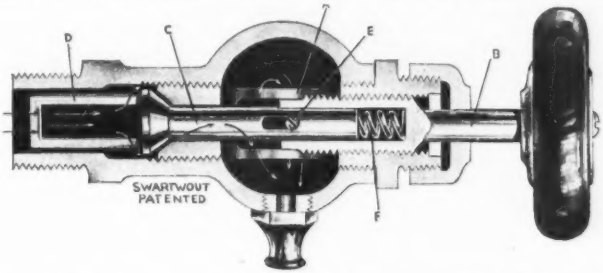
The use of the gooseneck construction, as shown by the accompanying illustration, is one of the leading features, while the automatic valve with its removable valve case is the other. With



the gooseneck construction the gauge glass is offset from the gauge bodies so that the glass may be cleaned, replaced or blown out without in any way disturbing the gauge bodies or the valves. Because of the greater flexibility of the Swartwout, the strain common with other forms of gauge glass is practically eliminated, thus removing the greatest cause of gauge glass breakage. Goosenecks also permit a glass 2 to 4 inches longer than other forms, an important feature when the glass is 25 or 30 feet above the ground.

The internal construction of the auto-

matic valve and removable case is shown in both the accompanying illustrations. In the section of the gauge cock the arrows show the path of the water and steam. The spring F holds the valve away from its seat while the device is in use, and to close a valve the handle must be turned until the spring motion



is taken up. At the inner end of the valve there is a plate or flat projection D which acts as a scraper to loosen any sediment gathering in the boiler connection. With every turn of the hand wheel it revolves, thus maintaining a free opening. The valve is self-regrinding, every turn of the hand wheel moving the valve on its seat, so that whenever it is necessary to clean the valve parts or replace a broken glass the turning of the hand wheel causes the regrinding action.

The illustration of the water gauge shows how independent of the gauge glass is the gauge body, and the removable valve, the valve and seat is removed by taking out the valve casing A, which may be done without disturbing the gauge bodies or boiler connections. A small screwdriver or penknife will readily remove the screw E, which operation releases all the parts. In the ordinary forms of gauge glass the removal of the valve requires also the removal of the gauge bodies. A steam tight joint can be made by an extra turn of the gauge body, and repetitions of this operation make it extremely difficult to maintain a steam tight joint. With the Swartwout design the gauge body is never disturbed after it is once in position.

To operate a gauge glass and keep it in good condition is extremely easy. The glass is cleaned by removing the plug at the top or the drain cock at the bottom and inserting a swab; the glass need not be removed nor the packing disturbed. In blowing down the water column the valves never require resetting, and every time it is blown down the exact condition of the valves is apparent.

The Swartwout automatic safety water gauge is made to stand pressures up to 250 pounds per square inch, thus adapting them to all types of boilers and all kinds of service.

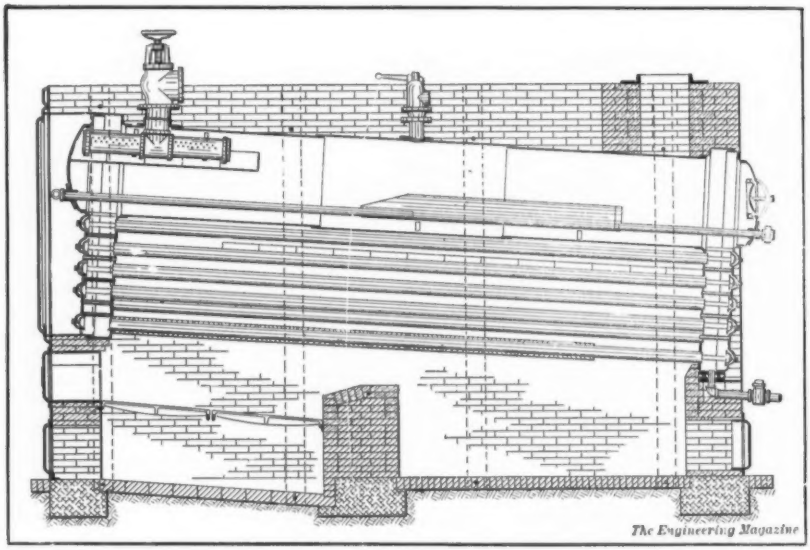
Wilkinson Safety Water Tube Boiler.

THE accompanying illustrations clearly show a new type of safety water tube boiler recently put on the market by the Oil Well Supply Company, of Pittsburgh, Pa., and built at their boiler works department, Oswego, N. Y.

The first illustration shows the boiler in front elevation, showing the headers in circular form, and also the layout of the tubes. The peculiar layout of the bottom row of tubes, as will be noticed, provides an equal distribution of the products of combustion along the entire length of the tubes, and also permits of a larger area for the combustion of the gases, than would be the case if the tubes were on a horizontal line.

The other drawing shows the boiler in horizontal sectional elevation, showing clearly the manner in which the inside and outside header sheets are connected. The sheets are flanged by what is known as the spinning process,

and when finished are pressed one into the other, and then riveted with a single girth seam, the calking edge of which looks outward and can be examined at all times without interfering with the brickwork. The circular form of the headers forces all foreign substances to collect at one point at the bottom, and, as there are no corners in the construction of these headers for any sediment

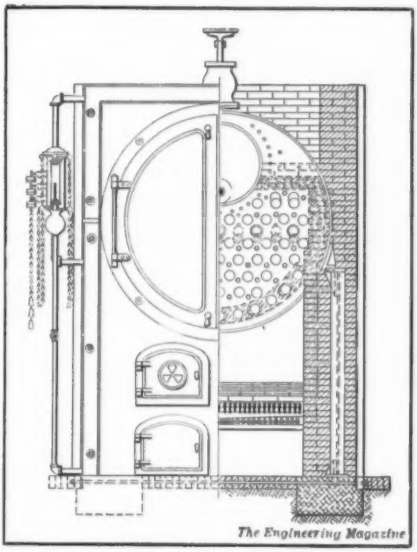


or scale to lodge, they can be easily cleaned by blowing off. Another imporant feature is the manner in which the drum is connected to the inside header sheet, being flanged out to meet the drum shell, thus leaving a clear passage from the drum to the header. In other words, there are no straps or bars used in connecting the header with the drum, thus allowing a free circulation of the water from the headers to the drum, and consequently free liberation of steam. The inside of both header sheets can be examined and cleaned with a hose by entering the drum through a manhole in the rear head. This feature alone must commend itself, especially where impure feed water is used, for when header sheets cannot be examined and thoroughly washed out, scale will form, especially on the inside header sheet, and in time the sheets become overheated and the tubes loosen. Of course, the tube handholes could be removed for cleaning out purposes, as has to be resorted to in other types of water tube boilers. Not only is this a tedious operation, but a very unsatisfactory one, as a thorough examination cannot be made of the inside sheets even when a number of handholes are removed.

The dry pipe is located well to the front and protected by a system of baffling which makes it impossible for any water to pass over into the separator. The feed is introduced through the front head of the drum through a pipe leading into the settling chamber, the end of which is tapped for surface blow-off, as shown. As will be seen, the lower row of tubes is encased with special locking firebrick, forming the lower baffle, otherwise the water in these tubes, being subjected to the hottest part of the fire, would be driven out, owing to the very rapid circulation. These locked baffle

brick cannot possibly fall out of place, although easily removable for repairs. The upper baffles are laid on the tubes in the usual manner and passed through either front or rear heads, as shown.

No side cleaning out doors are necessary in this type of boiler, as the tubes can be blown out from both front and rear through hollow stays, each stay taking care of four tubes, being made especially for this type of boiler.



These boilers are built in units of from 50 to 500 H.P., and for a safe working pressure of from 160 to 250 pounds, as may be desired. They are of all-steel construction throughout—no cast iron being used. The nozzles, hand hole plates and guards are made of special semi-cast steel. The tubes being straight can be removed from either front or rear end, and all handhole plates are made fast from the pressure side and fitted with a special type of asbestos metallic gasket. They are suspended by a system of steel beams and hangers, which allow the boiler to expand and contract in all directions, without injury to itself or to the brickwork. All boiler headers in units of 350 H.P. and upward, are fitted with double drums, and all units below 350 H.P. are fitted with single drums, which are of proper dimensions to give unusually large steam storage capacity.

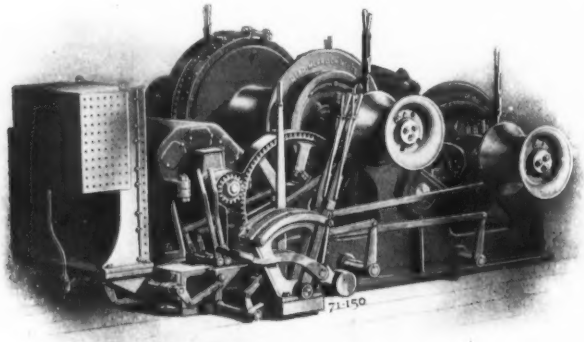
Exhaustive tests made on several batteries of these boilers, show that the steadiness at which the water level is carried and the dryness of the steam are unusual. The economy in the consumption of fuel is also very pronounced, especially where a low grade of coal is used. These essential requirements, coupled with the fact that, owing to its design the cost of the Wilkinson safety water tube boiler is reduced to a minimum, should make it especially worthy of the consideration of all intending purchasers.

Electric Erecting Machines.

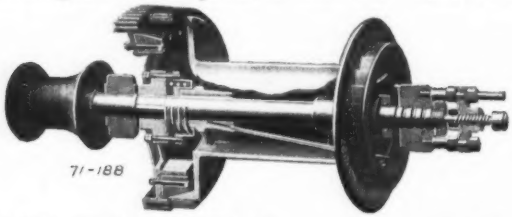
THE accompanying illustrations show several electric hoists furnished by the Mead-Morrison Co., of Cambridge, Mass., for the purpose of erecting the new P. & L. E. bridge over the Ohio River at Beaver, Pa. This bridge is one of the largest in the country from the viewpoint of heavy construction. It is said that there is more steel in the 750-foot channel span of this bridge than there was in the 1,350-foot channel span of the Quebec Bridge.

These machines are special and of heavy construction and were selected because of their peculiar adaptability to the work in hand. One of the advantages they possess is the use of Mead-Morrison twin screws, by which the friction drums are operated, the construction and arrangement of the twin screws making it possible to extend the shaft beyond the thrust bearing to receive the spool, and this extension is effected without in any way reducing the efficiency or satisfactory operation of the friction drums. The twin screws are of small diameter, and the same sensitiveness and power of operation is obtained as with the usual arrangement of outside screw furnished with contractors' engines. In

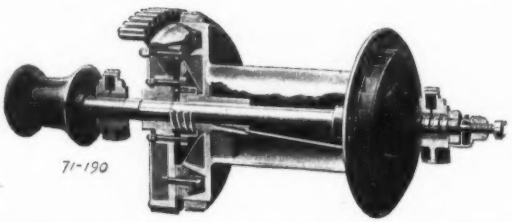
the arrangement of this machine it will be noted that the cut steel gearing at

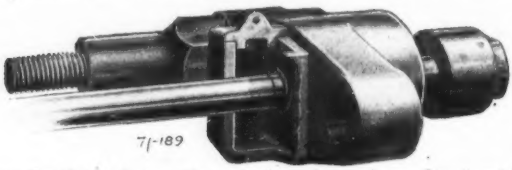


the motor is kept within the frame. The other gears and the pinion of these ma-



chines are of steel, and the construction of the machines throughout is extra heavy. All thrust bearings are of large area and are provided with renewable, split, bronze thrust washers. It will be noted that each spool is provided with a clutch level, by means of which it can be





unclutched from the shaft when desired.

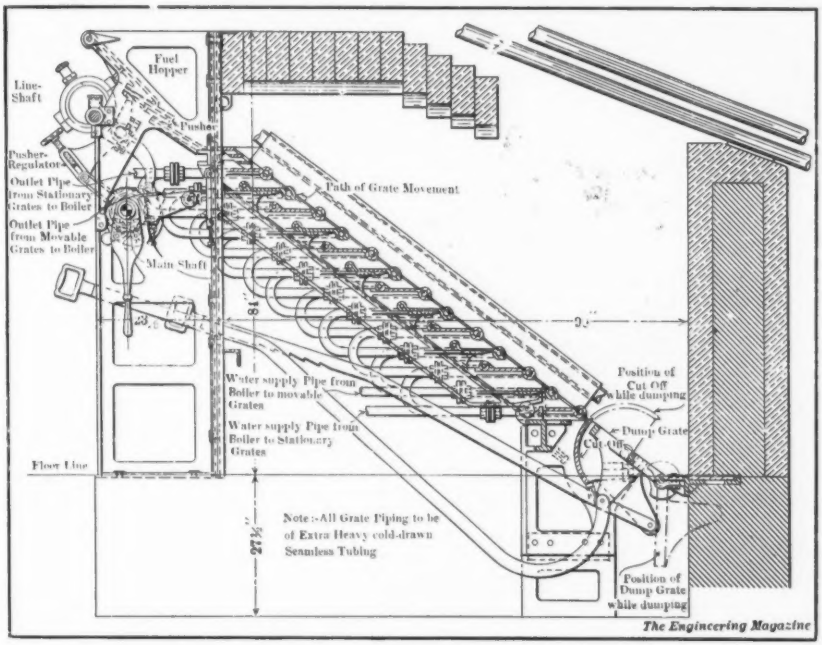
The large hoists are built for a capacity of 100 tons on a 13-part purchase and handled properly a test load 25 per cent in excess of this capacity.

In addition to the regular differential hand brakes with which each drum is equipped, each hoist was fitted with a Mead-Morrison automatic brake, which applies automatically and positively prevents backward rotation of the gears when the motors are idle. It was selected in preference to the usual solenoid electric brake, as the strains resulting from its sudden application, are taken up by the heavy shaft and side housing of the hoist proper rather than by the delicate mechanism of the motor. The drums were fitted with double cone friction instead of being actuated by the usual friction screw, pin and cross key and collar mechanism.

These machines handled very successfully the erection of the bridge in question, which is now practically completed, and some of them have been forwarded to Kansas City to be used in the erection of a bridge at that point.

The Lehigh Stoker.

THE Lehigh Stoker, as will be seen by the engraving, is composed of a series of horizontal shelves arranged as steps to form an incline of about 36 degrees with the horizon. Between these shelves are the spaces for admitting air to the fuel. At the top is a hopper, into which the fuel is delivered. Reciprocating in the bottom of this hopper are cast iron pushers, which shove the coal upon the top grates. The reciprocation of these pushers is adjustable according to the fire desired. The shelves forming the grates are of two kinds, fixed and movable, alternating in position. The fixed grates are attached to the side risers adjacent to the furnace walls. The movable grates between and attending with them bolted to risers resting on rollers at this lower end and carried by having eccentrics at their upper end, to which they are attached by jointed links. These eccentrics give to all the movable grates a reciprocating motion sufficient to force the coal upon and in front of them from the grate to grate, the incandescent fuel being thus positively compelled to progress from top to bottom. This frees the burning coal from its coating of ash, which is shaken off, giving access to the oxygen seeking the heated carbon. The motion is invariable in its amplitude, but controllable as to its frequency. In conjunction with the adjustment of the pushers any desired thickness of fuel upon the grates may be maintained.



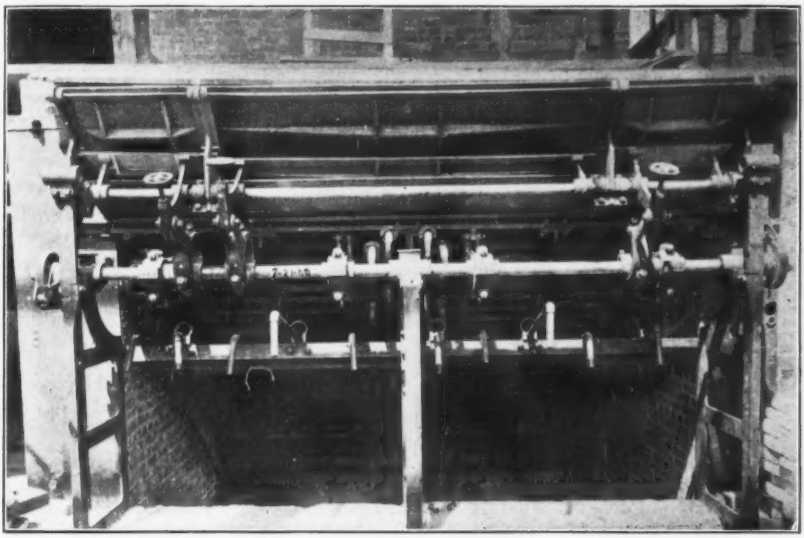
In the interest of economy, however, the coal should be nearly burned out

when it reaches the dumping grates, with enough fuel yet burning to keep a line of fire over the grates at that point with the ash gradually accumulating below it. At the proper time a cast iron screen operated by a rod from the front is raised, separating the completely burned ashes from the burning

coal. The dump grate, by means of its connecting rod, is then dropped and the dead ashes fall into the ash pit. The dump grate is then returned to place and the screen dropped back, the coal resting upon it following upon the dump grate.

It will be seen that the alternated moving grates all reciprocate simultaneously, being joined as it were in a moving sash. The moving grates have no charge of relation to each other. As previously stated, they obtain their motion from eccentrics. These eccentrics are keyed upon a heavy shaft, upon which is a ratchet wheel turned by pawls engaging the ratchet teeth. These pawls are pivoted in a pawl carrier oscillated by eccentric on the main driving shaft. By means of an ingenious device the number of teeth in the ratchet wheel which the pawls are permitted to engage is controlled by the attendant, who by this means governs the frequency of the oscillations of the moving grates. By a simple mechanical movement the grates push the coal forward in a straight line. On their return, however, they rise with the lift of the eccentric and are then carried clear of the coal upon the grate below, while the coal upon the moving grate itself, coming in contact with the fixed grate above is also more effectively moved to the front edge and pushed off by the receding motion. As a consequence, the fuel must move positively from grate to grate with each reciproca-

tion. There is no waiting for the fuel to spill or slide from grate to grate. As a further result of the motion described, the air space is unimpaired, and any tendency to sift the coal to the ash pit is obviated. The positive motion given to the fuel bed is most effective in preventing any lodgment of fuel or clinker. Such lodgment of fuel or clinker would form barriers, behind each of which would develop bare spots, permitting the inrush of cold air, to the great detriment of economy and the possible injury of the boiler.



With most stokers it is not advisable to push them to the point where the best efficiency is reached. This is because of the destructive effect of the fire upon the stoker itself. In locomotive boilers it is common to burn coal upon the grates at the rate of 100 to 150 pounds upon each square foot per hour, while in ordinary stokers the usual maximum performance obtained is 24 to 26 pounds of coal per square foot of grate per hour. In locomotives, however, the great intensity of the forced draft keeps the grates relatively cool, while the water in the boiler protects its plates from injury. A locomotive boiler is, moreover, in maximum service but a few hours before its return to the round house for inspection.

By means of seamless drawn steel pipes, embedded in the grates of the Lehigh stoker when they are cast, cooling water is permitted to circulate freely through them. Treating the moving grates as one unit and the stationary grates as another, water is passed in at the bottom grate of each series, thence ascending from grate to grate until the top is reached, when the water is passed off and its heat utilized if desired, by employing it as feed water. In passing from grate to grate the water is conveyed by bent pipes joined by couplings, with brass seats ground to a ball and socket fit. There is neither packing nor movement in the joints—the ball and socket joint simply assures that its parts shall come into perfect relation to each other. The stationary grates have fixed pipe connections in the ordinary manner. The movable grates have their terminal pipes of such lengths and in such positions that they spring readily with the movements of the grates, so that no

moving joints are necessary. The effect of this water circulation is to keep the grates from burning out, and thus to prolong their period of useful life in the stoker. Clinkers do not stick to grates so cooled, and, while with certain fuels clinkers will form, these grates so cooled assure their delivery to the dumping grates without creating a disturbance in the fire or requiring great effort to dislodge them.

In furtherance of this principle there are supplied also side cooling plates for the side walls, set just above the grates and provided with water circulation through 2-inch drawn steel seamless pipes. These pipes are flattened to increase their range of efficiency and are embedded in the cast iron side plates. The coal and clinkers do not stick to these plates as they would to the fire brick were the plates not provided. Above the mouth of the hopper opening is another cooling pipe, cast in. This is to prevent any distortion of the hopper back plate due to fire working back into the hopper. This should not be permitted to occur, but sometimes a banked fire burns up faster than the attendant expected, in which case damage may be averted by the presence of this pipe. The front plates of the hopper pivot at their upper edge, and when the hopper is not full of coal they may be swung back, permitting kindlings to be placed upon the grates and the quick spreading of banked fires, so that the stoker may be speedily put into full operation. The main shaft of the stoker is driven at about 20 R.P.M. by a small engine upon a pier at one side. One engine may drive several stokers, the power required being small. There is provision for operating both the pusher plates and the movable grates by hand whenever it may be required.

These stokers are made by the Lehigh Foundry Co., Fullerton, Pa., who will send illustrated catalogues and full particulars to any inquirer on request.

Industrial Notes.

—Orders have recently been placed by the Buffalo Foundry & Machine Company, Buffalo, N. Y., for buildings, equipment, etc., required for their large new machine shop. Several years ago this company took up the manufacture of vacuum drying machinery and all the various appurtenances connected with vacuum drying apparatus, such as vacuum pumps, condensers, evaporators, superheaters, dust filters, etc., and also absorbed the David Bell Engineering Company, continuing to manufacture the Bell steam hammers as one of its specialties. These lines have now grown to such an extent that the company is compelled to extend its machine shop facilities, and have decided to build a machine shop that will be as well equipped in its line as their foundry is in its equipment. The new machine shop will be built north of their present foundry, on property lying between Scajaquada Creek and the New York Central Belt Line, which railroad connects it with all the various lines in Buffalo. Approximately $200,000 will be spent at the present time on the machine shop. The building will be of steel and concrete construction, with traveling cranes in all the bays and galleries. The cranes will be of a capacity to easily lift individual pieces weighing as much as 200 tons each. Orders have been placed for exceptionally large machine tool equipment, all the tool equipment having been ordered special so as to obtain the highest production and get an exceptionally large range of work. All the tools will be motor driven, the motors being twice the size ordinarily used on the same machines. The entire plant will be operated by Niagara Falls power. This Company is about to take up several other lines of manufacture, in addition to those they are already in, and will also continue to make a specialty of general jobbing machine work.

—The Exeter Machine Works of Exeter, N. H., has recently changed hands. Joseph H. Symonds, the new President, has assumed the management of the factory, and Frank H. Burtt, and Arnold W. Heath, treasurer and secretary respectively, will direct the new Boston office at 35 Federal street. William Burlingame, who has been in complete charge since 1867, retires to less active duties. The company will continue in the manufacture of its former line of blowers, exhausters, and heating and ventilating apparatus, and in addition will manufacture the "Anti-Friction" brand of axle, engine and transmission greases and oils, patent axle box and lubricator.

—A. P. Witteman Company, of Philadelphia, with works at Chester, Pa., have taken over the contents and equipment of the Portsmouth Forge Company, Portsmouth, N. H., and will remove such portion of the equipment as they shall require for their plant at Chester. To accommodate this additional equipment the Witteman Company is at present preparing plans for the erection of a new forge shop, and an addition to their machine shop.

—The Robins Conveying Belt Company announce that arrangements have been made for the removal of their executive offices and sales, engineering and purchasing departments to the Park Row Building, 13 Park Row, New York. This suite was occupied by them up to two years ago, when their general offices were removed to their works at Passaic, New Jersey, and a branch office opened in the Terminal Buildings at 30 Church Street, New York. The office at the Church street address will now be discontinued and combined with their other offices in the Park Row Building.

—Among the schools recently equipped with heating and ventilating apparatus manufactured by the Massachusetts Fan Co. are the Rayen high school and the South Side high school, both of Cleveland, Ohio. The former has a 140 inch 3/4 housed fan with a heater of eight sections, and the latter a 180 inch 3/4 housed fan with two heaters of eight sections each.

NEW CATALOGUES AND TRADE PUBLICATIONS.

These catalogues may be had free of charge on application to the firms issuing them. Please mention The Engineering Magazine when you write.

Automatic Screw Machines.

NATIONAL-ACME MFG. CO., Cleveland, Ohio.—A most artistic and beautiful specimen of the printer's art is the new catalogue of the National-Acme Mfg. Co., illustrating and describing their celebrated automatic screw machine. It is printed on very heavy coated paper in tinted effects, every half-tone illustration is a work of art in itself, the many and remarkable products of the machine are shown in colors, and the text is so replete with detailed information that the work is entitled to the highest rank as a handbook on its special subject and a model specimen of modern catalogue work.

Buckets.

HAYWARD CO., 50 Church Street, New York City.—A folder entitled "Cutting the Cost," presenting in detail the argument in favor of Hayward buckets.

Corliss Engines.

BATES MACHINE CO., Joliet, Ill.—Descriptive catalogue in two colors describing Bates Corliss engines, power transmitting machinery, complete motive power plants, and air and gas compressing machinery.

"SEVENTY-FIVE YEARS OF ENGINE BUILDING" is the title of a new and beautiful booklet recently issued by the C. & G. Cooper Co., Mt. Vernon, Ohio, giving a complete history of the development of the business of this widely-known firm, who are builders of the celebrated Cooper-Corliss engine. Young engineers will be especially interested in the historical information given as to the development of the engine-building science in America, and the firm will be pleased to send the booklet free of charge upon application.

Drainage Excavators.

F. C. AUSTIN DRAINAGE EXCAVATOR CO., Railway Exchange, Chicago, Ill.—A very valuable catalogue of 112 pages (6½ x 9½ in.), illustrating the remarkable automatic machinery which has been developed in recent years for ditching in irrigation regions, and especially in swamp lands. The many fine photographs presented serve as a revelation of the remarkably fast, effective and economical work now accomplished by the modern types of drainage and excavating machinery made exclusively by this firm, and the text is so complete in detailed information that the work is really a text-book of great value to every engineer in any way concerned with irrigation and drainage problems. Free on application.

Dryers.

RUGGLES-COLES ENGINEERING CO., Hudson Terminal Building, New York City.—Descriptive catalogue of Ruggles-Coles dryers. The Class A dryer consists of two concentric shells. The outer cylinder is made of heavy steel plates, the longitudinal seams having butt joints, with inside lapping strips. The inner shell or flue is also made of heavy steel plate and is connected with the outside cylinder at the center by heavy cast-iron arms, solidly riveted to both cylinders so as to hold the shells rigidly together. Between the cylinder and each end are two sets of swinging arms which allow for the unavoidable expansion and contraction due to the difference in temperature. This construction prevents any shearing of rivets or loosening of joints, which is a most serious defect in some styles of construction.

Elevator Controllers.

CUTLER-HAMMER MFG. CO., Milwaukee, Wis.—A new and very valuable booklet of 130 pages (4½ x 8 in.) fresh from the press and bringing the science of electric elevator control squarely up to date. It presents a mass of tabular and technical information of the highest value to engineers and others who are concerned with this particular problem in electrical control. Fully illustrated and free on application.

Gas Engine.

BUCKEYE ENGINE CO., Salem, Ohio.—An excellently arranged catalogue describing in detail the Buckeye four-stroke cycle gas engine. The opening pages discuss in the clearest manner the fundamental principles of utility and simplicity of gas-engine design. There are many tables comparing the gas engine with the steam engine in efficiency and economy, and a brief discussion of the available fuels for the production of power.

Illumination.

WESTERN ELECTRIC CO., 463 West Street, New York City.—Pamphlet entitled "How to Figure Illumination," the object being to acquaint the general public with the most up-to-date method of figuring the illumination required under any given conditions.

Pumping Machinery.

MORRIS MACHINE WORKS, Baldwinsville, N. Y.—Catalogue describing centrifugal pumping machinery, stationary and marine engines, centrifugal pumps and engines, Morris have been on the market for about forty-five years.

Rope Driving.

"TWENTY-FIVE YEARS OF ROPE DRIVING" is the title of a very handsome illustrated catalogue of 110 pages (8½ x 11½ in.) issued by the Dodge Mfg. Co., of Mishawaka, Ind., U. S. A. It illustrates and describes in detail every feature of the wide range of important work which this firm has done, in all branches of industry and in many parts of the world, and is a publication which every engineer should have in his library for reference purposes. Free upon application.

Tanks.

CHICAGO BRIDGE & IRON WORKS, 105th & Throop Streets, Chicago, Ill.—An excellent catalogue describing a line of water towers, stand-pipes, smoke stacks, grain tanks, riveted pipe, bridges, roof trusses, etc. All of the illustrations are taken from actual installations.

Traveling Cranes.

SHEPARD ELECTRIC CRANE & HOIST CO., Montour Falls, N. Y.—Bulletin No. 58 describing Shepard electric traveling cranes. All parts are enclosed in dust-tight cases and all gears run in oil baths. There are, all told, some 400 types of Shepard cranes.

Valves.

WATSON-STILLMAN CO., 50 Church Street, New York City.—Catalogue No. 78 entitled "Hydraulic Valves and Fittings," listing a great many types and combinations. Almost every page contains some hint or advice as to the best piping arrangements, what types or combinations of valves are best suited for certain work, how the valve arrangement may operate a number of cylinders for machines automatically, etc.

Vanadium Steel.

AMERICAN VANADIUM CO., Frick Building, Pittsburg, Pa.—A pair of attractive catalogues in German and French describing vanadium steels, their classification, and their heat treatment, as well as detailed instructions for the application of vanadium to iron and steel.

THE CURRENT RECORD OF
IMPROVED MACHINERY
NEW METHODS NEW MATERIALS
NEW APPLIANCES

1000 H. P. in Very Small Space.

RECENT changes that became necessary at the Hammermill Paper Co.'s mills at Erie, Pa., U. S. A., were made very satisfactorily and economically, yet at the expense of importing an engine of a type not yet being built in America. The fact that this peculiar engine was needed so badly as to justify the payment of a high import duty is an indication of the difficulty of the situation.

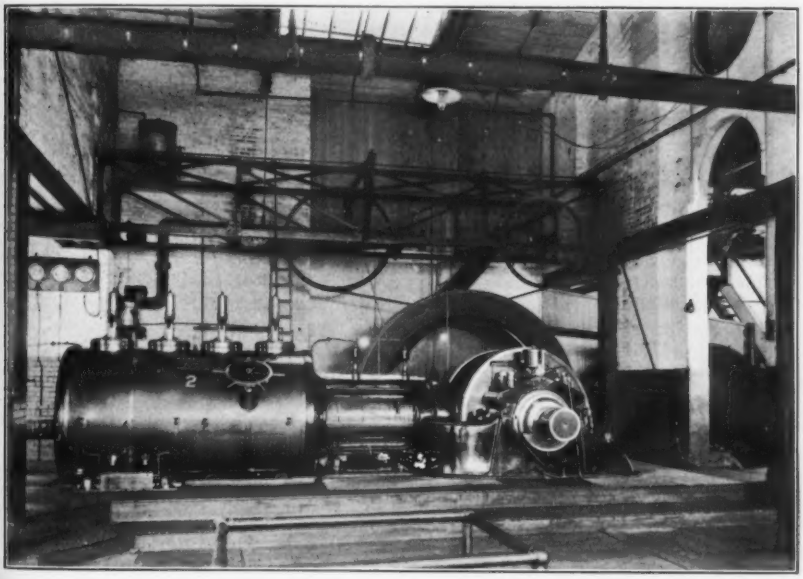


FIG. I. 1,000 H. P. IN VERY SMALL SPACE.

A large cross-compound Corliss engine was the main and sole source of power for the entire mill. Its broad wheel carried the ropes of two English or multiple loop rope drives, about two-thirds of the ropes leading forward to the main lineshaft, the other one-third running backward between the engine cylinders to drive a secondary line.

As additional machinery was gradually put in at various parts of the mill, the engine became overloaded and relief was necessary. The natural thing to do was to relieve the engine of the

load represented by the secondary line and leave it only the main line to drive. No prime mover of inferior economy would be acceptable, and within the space available no economical engine of standard American type could be installed. Being familiar, through its transmit all that the engine can deliver, or upwards of 1,000 h. p.

When the material for this new drive arrived, the Hammermill people, having been accustomed to the massive proportions, deep grooves, wide faces, big ropes, long centers, and other essentials

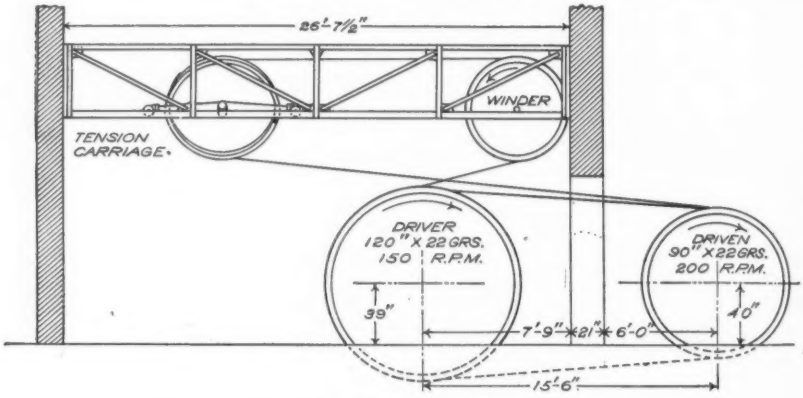


FIG. II. SIDE ELEVATION OF THE DODGE ROPE DRIVE.

German connections, with the Lentz type of engine, the Hammermill company decided to import an engine of this type, and the solution of the problem was in the combination of this extremely short type of engine with the Dodge American system of rope drive which operates with success on short centers.

Fig. 1 gives a glimpse through the archways in the old wall into the main engine room, where the driven sheave on the secondary lineshaft may be seen, and Fig. 2 shows side elevation of the rope drive. The distance on centers from engine shaft to lineshaft is only 15 ft. 6 in. The sheave diameters, giving speed increase from 150 r. p. m. at the engine to 200 at the lineshaft, are 120 in. and 90 in., respectively, leaving about 6½ ft. space in the clear between.

The drive consists of 22 wraps of rope, served by a tension carriage traveling a horizontal track of steel construction overhead in the new engine room. It carries steadily and easily the load upon it and has ample capacity to and characteristics of the English system of rope driving, were fearful that the Dodge wheels, steel structure for tension carriage, etc., were not right for the duty expected of them. On communicating their doubts to the Dodge company, they were assured that there was no error in the work, and were requested to "wait and see," with full understanding that the success and sufficiency of the entire equipment was backed up by all the experience and resources of the Dodge Manufacturing Co. of Mishawaka, Ind., U. S. A.

Nobody can question the strength of such a guarantee, so they "waited"—and "saw." The drive operated perfectly and proved its efficiency and sufficiency from the start.

Because the conditions and equipment are so unusual, and so interesting to power plant engineers, the Dodge company has printed a detailed description of the plant, giving exact dimensions of the engine, etc., and this they will be glad to supply on application. It is only

necessary to add here that the features of this engine are: extreme simplicity and compactness; greatly reduced number of working parts in valves and valve gear; a very simple shaft-driven governor which, if stopped for any reason, will shut the engine down instead of letting it run away; the possibility of running at a very high speed—up to 300 r. p. m. or more—without impairing the economy; and poppet valves which are seated quickly yet without shock, and are particularly adapted to high pressures and high superheat, and which—most important of all—have no frictional surfaces, either sliding or rotary, and therefore need no lubrication and remain always tight. In Germany a steam consumption of less than 10 lb. per horse power is reported to have been attained with highly superheated steam.

The Lentz system has been adopted widely abroad and is used on locomotive and marine engines as well as in stationary practice. A large number of engine builders in Germany, Holland, Belgium, France, Italy and England are using the Lentz patents, and the American rights have been acquired by the Erie City Iron Works, at Erie, Pa.

The Hydraulic Bending Machines.

THE Watson-Stillman Co., of New York, has just introduced two new bending machines, which should prove of interest to all who have large pipe, structural sections, automobile parts, metal bars and similar sections to bend. The frames and cylinders of these machines are cast iron and the cylinders are copper lined. The rams and bending pins are machinery steel. A positive stop is provided in both instances to prevent the ram from passing out beyond a safe limit. The smaller machine is capable of exerting a power of 25 tons under a hydraulic operating pressure of 2,200 lbs. per square inch. The table is 2′ by 3′ 4″ and is provided with 18 round holes staggered in rows which are symmetrically placed with respect to the ram. Round pins each 3½″ in diameter can be placed in any of the holes, and the work may further be held to place by bolts set in any of the key slots on the top and sides of the table. Modifications of this table top are made where necessary to conform to some special use.

The ram has a travel of 8 inches and is brought back to the beginning of the stroke by a counterweight. The center

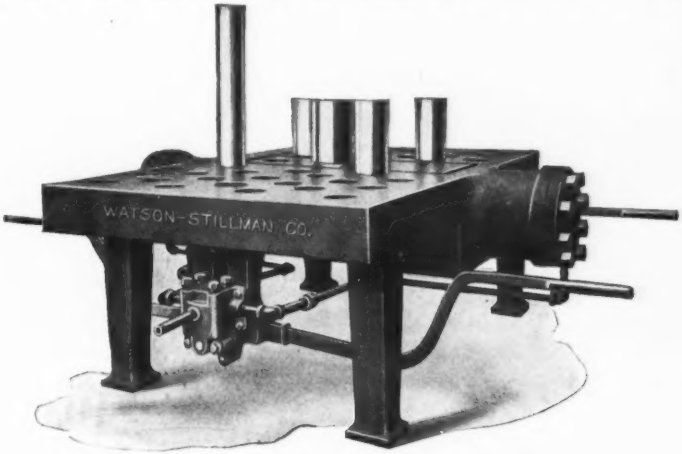


FIG. III. HYDRAULIC BENDING MACHINES.

line of the cylinder is 2¼ inches above the table, but this machine can be made with the bending block higher above the table, or by making the ram travel in guides the center line may be below the table. The cylinder head is removable and provided with air passages for removing entrained air or draining if desired in cold weather. Operation of the ram is controlled by a stop and release valve at the side of the cylinder.

The second bender is considerably larger and capable of exerting 30 tons' pressure. In this instance the table is 4′ by 6′ and has two opposed 7-inch cylinders of 12-inch stroke arranged to operate in either direction, the double headed ram extending between them. The table as shown has 21 holes on each side of the ram, staggered in six rows. The movable pins are interchangeable and 4½ inches in diameter. The larger or bending pin shown in the center is attached to a saddle on the ram. The ram works in machined guides and is covered, to prevent scale or dirt from reaching the contact surfaces. These surfaces are further protected from dirt by plugging the oil holes in the cover with screw plugs. As in the smaller press, the cylinder heads are removable and provided with air passages which also permit drainage. The valves are placed in one body and may be operated by any of the four levers at the corners of the press. The arrangement is automatic, so that opening of pressure or release valves for one cylinder opens the opposite valve of the other cylinder, the movement being stopped by removing the hands from the lever. A pair of bending blocks faced with a hard steel may be substituted for the bending pin. The cylinders are cast higher up for uses where it is desirable to obtain greater power. In this instance the rams are usually made independent and single on the small machine.

The Watson-Stillman Co., 54 Church Street, New York City, will furnish further particulars relating to this or any other form of bending machines.

Modern Skylights.

IN his very interesting paper in the March number of THE ENGINEERING MAGAZINE on "Industrial Applications of Reinforced Concrete—Structural Details of Roofs, Skylights, Stairs, etc.," M. M. Sloan draws particular attention to the fireproof qualities of wire glass held in metallic frames in sawtooth skylight construction. A form of skylight specially adapted to this type of roof is the "Anti-Pluvius" system, which is being rapidly adopted in modern factory construction. This is a puttyless construction, built on the unit system. Its special adaptability to varying climates is shown by its successful use in all parts of the United States, as well as in Europe, Mexico and Panama.

The main supporting bar of the "Anti-Pluvius" skylight is of high carbon steel, a special rolled shape adapted to skylight work, which will carry a continuous skylight of eight feet.

A continuous clip, which is patented, is first placed on the curb, angles having first been riveted to it, giving the proper spacing for the skylight bars, which, in building up the skylight, are placed at the intervals and bolted to these angles. The continuous clip to which the skylight bars are bolted is in turn bolted to the curb, or if channels or angles are used the clip is formed in a U shape and set over the angle or channel, thus insuring a skylight free from the wind tearing it off the roof. This continuous clip makes a solid construction and overcomes many of the disadvantages of the ordinary skylights.

Stirrups are fastened in the bars at intervals of from 16 to 20 inches, into which are screwed brass studs with a shoulder on the upper end. A flat plate, together with a strip of cow-hair felt, and a sheet metal guide for the felt, are placed over these stirrups. The stirrups elevate the glass above the lip of the bar so that the atmospheric conditions inside the building surround the bar, tending to reduce rusting or corrosion and giving a longer life to the painted

surface. The glass rests on the felt and is covered by another strip of cow-hair felt with a top cap, which may be of any metal designated. The cow-hair felt is a non-rotting material, and has only been arrived at after a number of years of experimenting. Elongated holes are made in these metal strips and the top one has a washer to cover the elongation. A spring is set over the neck of the stud, and on the shoulder of the stud, stopping its downward course, is placed an inverted U-bar, known as the bridge. A nut secures it fast, setting the spring at tension, which provides a firm, elastic pressure to hold the glass in place.

The steel spring, is coppered, galvanized, and japanned to protect it from rust.

No sweating will occur on the supporting bar, due to non-contact with the glass and its elevation above it. No chill from the outside can be conveyed to the inner bar by contact. The spring and felt take up the expansion, contraction, and vibration, and reduce the breakage of glass to a minimum. A bridge for walking on the skylight, the weight of a man being borne by the supporting bar without contact with or pressure on the glass, allows free and ready access to all parts of the skylight. It is built in units, and by using the bridges, lights of glass can be removed, one or two at a time, turned over and cleaned, the inner bar repainted inside and outside, and the glass replaced in much the same fashion.

The supporting bar acts as a channel for the condensation water, and where lapping is necessary graduated stirrups are used to elevate the upper light, and it is rested on the lower light with a strip of cow-hair felt between, the projection of the glass underneath being used as a gutter for the condensation water from the upper glass. Any water collecting on this lower glass projection will drain through the felt, or is carried by it into the channels, and thus on down and out through the dripholes at the lower flashing. The flashing of the curb is done by the roofer in order to make a perfectly tight connection. The continuous clip sets over the roofer's flashing on the curb, and the apron of the "Anti-Pluvius" skylight comes down sufficiently to make a proper connection with the other flashing.

The "Anti-Pluvius" is a skylight with a "steel backbone" and can be put together and taken apart with a wrench and screw driver. It is weather tight and will stand up in service many more years than any other skylight construction.

It seems to appeal to all classes of architects and engineers, and is being specified by a large number. Its unit form of construction makes erection easy, and while it is slightly higher in first cost than the ordinary type of skylight, it soon saves the difference and then earns a profit for its owner. It is adapted for all classes of work where results are wanted. It is a practical skylight proposition, and is permanent, with freedom from continual petty troubles, which are costly. The "Anti-Pluvius" system is manufactured by the G. Drouvé Company, Bridgeport, Conn., who have issued an interesting pamphlet showing a number of installations of this particular type of roof light for the principal railroads and industrial plants. A copy will be sent to any one on request.

Transmission System of the Idaho-Oregon Power Co.

THE present transmission system of the Idaho-Oregon Light & Power Company, in the region surrounding Boise, Idaho, comprises two water power generating stations, one of 1,500 kilowatts capacity at the Horseshoe Bend of the Fayette River, and one of 900 kilowatts capacity at Barber Dam on the Boise River, six miles from the city of Boise, together with about 112 miles of high-tension transmission line, approximately one-half of which operates at

the transmission potential of 66,000 volts and one-half at 23,000 volts.

The two generating stations above referred to now supply the principal load of the system, the lighting and traction service of the city of Boise, through 23,000 volt lines. To supply the region north and west of Boise where, besides the local service, power is used for mining, a transformer sub-station has been installed at Emmett, 42 miles from the city and 16 miles beyond the power plant on the Horseshoe Bend line, stepping up from 23,000 to 66,000 volts through three 1,000 K. W. delta connected Westinghouse transformers. From this station the 66,000 volt lines continue through the Plymouth and Ontario sub-stations to the Weiser sub-station. Sixty-five miles northwest of this point, the Idaho-Oregon Company is building the Oxbow hydraulic water-power plant on the Snake River, which will make available approximately 30,000 horse power, and will ultimately be used to supply the principal load of the system at Boise, at a transmission distance of 125 miles. When the Oxbow station is completed and put into operation, the Horseshoe Bend and the Barber Dam plants will be operated as auxiliary generating stations.

FIG. IV. INTERIOR OF EMMETT SUB-STATION, IDAHO-OREGON POWER CO.

The principal sub-station, both in the present plant operation and in the transmission scheme including the new Oxbow stations, is that at Emmett. This station equipment includes three delta connected 1,000 kilowatt transformers, stepping from 23,000 to 66,000 volts, for transforming the principal through load; and three 100 K. W., 66,000 to 2,300 volts, transformers, star connected, for the purpose of supplying the local distribution lines in

the territory adjacent to the station.

The in-coming 66,000 volt lines from Ontario and Weiser, of stranded aluminum cable of a carrying capacity equivalent to No. 1 copper, are brought into the Emmett sub-station past aluminum cell, electrolytic lightning arresters, and carried through disconnecting switches to impedance coils, and thence to the 66,000 volt station busbars. Feeding from these, the main power load of the system is led through three Westinghouse type "GA" oil circuit breakers to the group of 1,000 K. W. transformers stepping down to 23,000 volts. The low tension terminals of these units are connected through Westinghouse type "E" oil circuit breakers to the line, after passing lightning protective apparatus, in general similar to that on the in-coming 66,000 volt lines. The second circuit taken from the 66,000 volt station busbars is led, through a similar set of type "GA" oil circuit breakers, to the 100 kilowatt transformers of suitable ratio, lowering to the 2,300 volt distribution voltage. From these 2,300 volt busbars, the feeder circuits are controlled by Westinghouse type "B" circuit.

Perfecting the Screw Machine.

THE gratifying advance that has been recently made in perfecting the automatic screw machine is fairly indicated by the illustrations here presented. These machines are no longer confined to plain round work, because they are now fitted with attachments for milling, slabbing, drilling, etc., which adds greatly to the range of work that may be completed on the machine. Parts which were formerly turned, threaded, etc., on the screw machine, and then afterwards milled, drilled, slabbed or slotted by hand, may now be finished complete on the machine without rehandling, and in a great many cases without increasing the production time.

The illustrations herewith show one of these attachments adapted to use on the Acme Automatic Four Spindle Screw Machine, which was recently put into use in the Cadillac automobile plant at Detroit.

The attachment is mounted on the cutting off tool slide, and operates in the

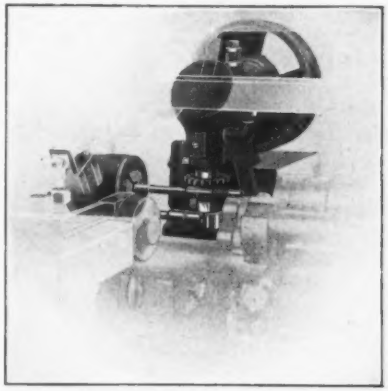


FIG. V. ATTACHMENT TO SCREW MACHINE.

third position while the piece is being threaded, formed and cut off in the other positions. In attaching and adjusting this attachment to the machine it is only necessary to drill and tap two holes in the cutting-off slide. The attachment is compact and fully auto-

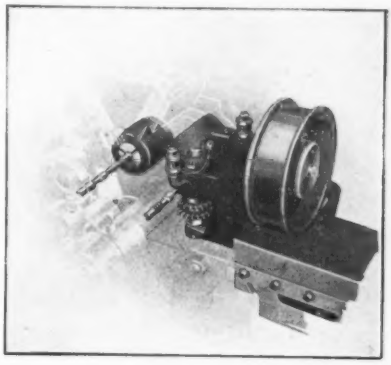


FIG. VI. ATTACHMENT TO SCREW MACHINE.

matic. The machine requires very little more attention with this attachment than without it; the saving is very evident as the second operation is entirely eliminated.

This piece is finished from cold rolled steel at the rate of 53 pieces per hour, which is about three times as many as had been obtained without the slabbing by the previous method. Details of this, and also other improvements in this celebrated machine, will be supplied by the builders, The National Acme Manufacturing Co., Cleveland, Ohio, U. S. A.

Sturtevant Electric Forge Blower.

THE Sturtevant electric forge blower is composed of a pressure fan of the "Multivane" type, enclosed in a pressed steel-plate casing, driven by a direct-connected electric motor built to operate from electric lighting circuits.

The particular features of this blower set are compactness and high efficiency, due greatly to the "Multivane" type of wheel.

The "Multivane" type of fan wheel is used in this set for the first time in an individual forge blower. This highly efficient fan means that the current consumption is less, and still it gives a greater pressure and volume of air than can be obtained from much larger fans of other models.

FIG. VII. ELECTRIC FORGE BLOWER.

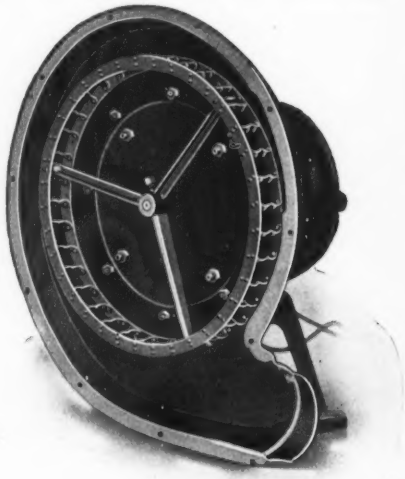


FIG. VIII. ELECTRIC FORGE BLOWER.

This blower connected to a forge with a tuyere area of 1.5 square inches brings to a welding heat 2-inch round soft steel stock in four minutes and 1-inch round soft steel stock in two and one-half minutes. In addition to its use with forges, for blow pipes, soldering tubes or anything of that nature this set will be found especially satisfactory.

These blowers can be set on a bench or shelf and the pipe run to the tuyere, or they can be set on a box or floor near the forge and be connected by piping, or if desired, can be bracketed to the forge and discharge directly into the tuyere. The casing is easily revolved to discharge in any desired direction.

This set weighs complete 35 pounds and measures 14½ inches from the floor to the top of fan case and 10 inches from the inlet of fan to outside

end of motor shaft. The base has four holes for screwing the blower to the floor or shelf or wherever desired.

Further particulars of this type of blower may be had from the B. F. Sturtevant Co., Hyde Park, Mass.

into the furnace as it is dripped in from the blast. The result was naturally a smoky inefficient fire with much oil wasted not only outside of the furnace but inside as well.

The next step forward was to devise

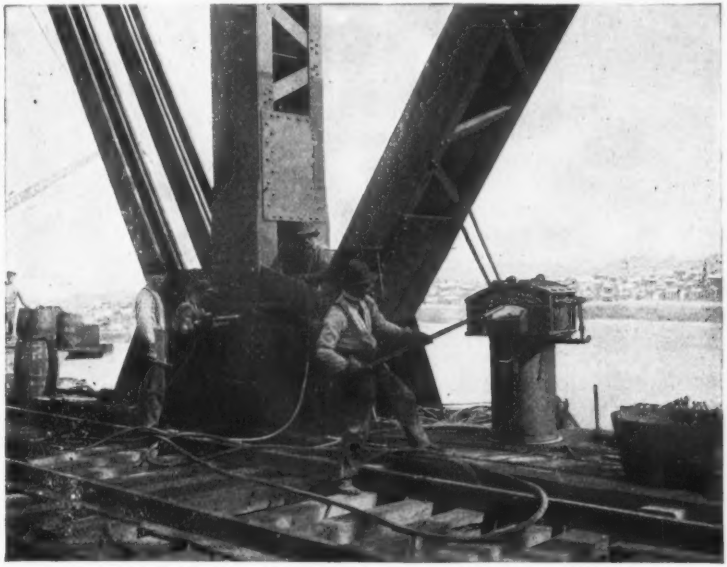


FIG. IX. HEATING RIVETS FOR THE OHIO RIVER BRIDGE AT BEAVER, PA.

Kirkwood Oil Burners.

THERE have been a number of oil burners of various kinds and types placed upon the market for furnaces, most of them, however, of faulty design and not constructed in accordance with the first principles of oil burning, namely, the thorough atomizing or vaporizing of oil (either with compressed air or steam), and the addition of natural air to insure perfect combustion.

The apparatus used for coal and coke furnaces were usually supplied with air under two to six ounces pressure for furnishing the oxygen necessary for the required temperature, and this same apparatus was used when oil was first substituted as a fuel, the oil being blown a burner which permitted the feeding of the oil to the furnace at the same pressure as the air blast (2 to 6 ounces) and although this marked a considerable step towards improvement, it was, however, shown that with this system the oil was imperfectly atomized, most of it going into the furnace in comparatively large particles. It will be seen, therefore, that with this system, known as the "drip" or "low pressure" system, the combustion does not take place immediately, the particles of oil simply burning on their outer surface and carrying the heat past the point at which it is needed and causing not only a smoky but wasteful fire.

For this reason the Texas and California oils, owing to their greater density,

cannot be used at all in burners of this type, although they are comparatively high in heat units. The only way in which such oils may be burned at all is by means of a high pressure burner requiring compressed air at from 15 to 20 pounds for its operation, this pressure being required both for atomization and combustion. When properly designed, such a burner will atomize and burn the fuel perfectly, but in so doing will require a very large amount of compressed air, necessitating a large investment for the air compressing plant and a considerable outlay for operating expenses. In fact, the operation of such a system involves an expense which makes it prohibitive for general use to say nothing of the very objectionable noise incident to its operation.

These facts have brought about the design of a combination high and low pressure oil burner in which the oil is fed to the burner at from 15 to 25 pounds pressure, and there atomized by a small quantity of compressed air (or steam under certain conditions) at a slightely lower pressure. After which an air blast of from 2 to 6 ounces is used to supply the necessary amount of oxygen for completing combustion.

This briefly is the principle upon which the Kirkwood combination high and low pressure oil burner operates, and it has been found that the amount of compressed air required for atomization is so small that the supply required for a number of burners is almost negligable in a plant using compressed air for other purposes. In cases where it is necessary to install the suitable apparatus for operating the oil burner it will be found that the small amount of air consumed renders the cost of plant a nominal one, while the operating expense will be very small.

Tests have proven that the Kirkwood combination burner will actually do the same work as any type of "low pressure" or "dip" burner, but with a 25% reduction in oil comsumption. The nature of the fire can be regulated by varying the amount of the air blast admitted.

The supply of oil and compressed air is regulated by one lever, the ratio between the air and oil always remaining at the constant point which is found to be the proper proportion for complete atomization, the adjustment being made before the apparatus leaves our factory, insuring a perfectly adjusted burner which cannot be impaired even by an ignorant or unskilled operator.

These burners have been used for the past three years in many of the large railroad and manufacturing plants in the United States and Canada. Tate Jones & Co., Inc., Pittsburg, Pa., have issued some very interesting pamphlets on oil burners which they will send free on request.

Self-Contained Grinding Machine.

THE accompanying illustrations show another new grinding machine designed on original lines and built by the Landis Tool Company, of Waynesboro, Pa. The entire machine is of high power and heavy duty construction, and, while intended for finishing all classes of work within its range, it is especially adapted for grinding chilled rolls. The regular practice in grinding the body on such work is to support the roll by its journals on bearings mounted on the table of the machine. Previous to this operation the journals or necks are themselves ground which is done with the roll carried on centers in the same manner as for regular plain grinding. The grinding wheel is 24 inches in diameter, and the guard is made to take these with faces up to 4 inches wide. The wheel can be used at full size in diameter for grinding 16-inch rolls, which occupies the full swing of the machine. To compensate for any slight error in the alignment of the headstock and roll axes and to avoid any tendency of the drive to influence the roll from its true axial position with the bearings,

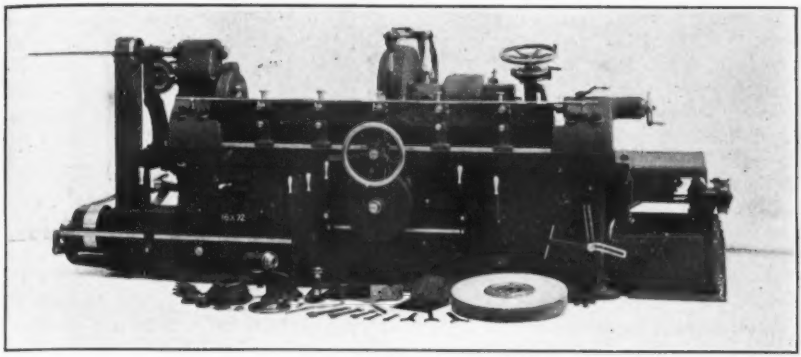


FIG. X. SELF-CONTAINED GRINDING MACHINE, FRONT VIEW.

an equalizing fixture is attached to the roll with equal force from opposite points across the center. The importance of keeping the roll face true and concentric with the journals in roll work is well known. To be assured of this when finishing on the grinder the above described method has been found to be a highly practical and reliable one. Another feature contributing greatly to accurate work is the stationary work table, which is supported its entire length by the main column of the machine.

The bearings for supporting the rolls when grinding the bodies and the equalizing driving fixtures are not shown in face of the headstock, which drives the the illustration, but become regular parts of the equipment when the grinder is furnished for roll work.

This machine is also adapted for railroad shop work for grinding locomotive pistons, piston valves, valve stems, crank, link and knuckle pins, axles, etc. It is provided with a gap, so that pistons can be ground with their heads in place, and also providing for the swing of valve yokes when grinding the stems. The gap can be located along the table to suit the work when the machine is built. The machine is of the self-contained type and is designed to be driven either with motor or from the line shaft.

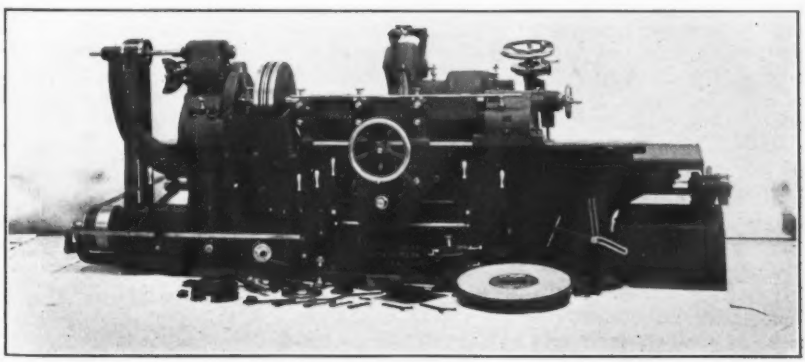


FIG. XI. MACHINE WITH GAP, FRONT VIEW.

With either form of drive the power is applied to the main shaft at the rear of the machine, from which it is distributed and transmitted to all of the different working parts. The grinding wheel is driven from a large pulley in the rear, located at about the center of the machine, which is mounted in a carriage rolling on a track shown, extending from the base of the machine, and travels with the wheel carriage as it is traversed. This pulley is driven by step grooves on the main shaft engaging rollers in its sleeve or hub, which makes practically a frictionless drive, as it is traversed or slides over the shaft. The grinding wheel belt is 6 inches wide and passes over intermediate pulleys so arranged as to take up automatically any change in its length and at the same time keep it under a uniform tension. This belt has almost 200 degrees contact on both the driving and driven pulleys, and its length can change about 8 inches by stretching before it becomes necessary to remove a section and shorten.

The grinding wheel head is massive and rigid, which is a feature so essential to rapid and perfect grinding. The spindle is of very large dimensions and is made of hardened steel; the bearings are of phosphor bronze, are self-aligning, are adjusted to tapers for taking up wear and have self-oilers. A very important feature of this wheel head is that the bearings are protected by special covers and are positively dirt proof. The grinding wheel has provision for balancing, this being done by two weights mounted to be adjusted in a circular or annular groove in the side of the wheel collar or center. The headstock is very powerfully geared and has ample power for driving the largest piece of work or roll that can be placed in the machine. It is arranged to give five changes of speed to the work, these being made mechanically by the movement of a single lever and by shifting a back gear in the gear box at the end of the machine. Another range of five speeds is obtained, making a total of ten work speeds. These speeds are indicated on a dial, and the changes can be made quickly and with ease. All parts of the clutch mechanism are made of hardened tool steel and all gears are finished by planing.

The work revolving and traversing mechanisms are driven from the gear box at the end, to which power is delivered by the belt from the main shaft. The work and traverse drives of the wheel are started and stopped together by a clutch in the pulley on the end of the gear box, which is operated by a lever at the front of the machine. These drives can also be operated separately, and their speeds are varied entirey independent of each other. The pump is driven from the end of the main shaft.

Industrial Notes.

—Wm. Graver Tank Works, East Chicago, Ind., have decided upon the manufacture of water softeners, having engaged the services of Kent W. Bartlett, who has been associated with the Northern Water Softener Co., Madison, Wis.

—William Wallace Christie, well known as a chimney specialist, author of "Chimney Design and Theory" and editor of the mechanical section of "Foster's Electrical Engineer's Pocket Book," has opened an office at 177 Broadway, New York.

—George M. Brill and Horace C. Gardner have formed a partnership under the name of Brill & Gardner, 1134 Marquette Building, Chicago, Ill., for the purpose of continuing the engineering and architectural practice heretofore conducted by Mr. Brill, who has been engaged for many years in constructive engineering work and for twelve years has specialized in the design of complete manufacturing and power plants. For over twenty years Mr. Gardner has held the position of manager of the construction and mechanical departments of Swift & Company, in active charge of a wide range of construction and engineering matters, in-

cluding all that pertains to packing-houses, industrial plants, cold storage, ice-making and refrigeration, and the building and maintenance of railway equipment. The firm will make a specialty of engineering and architectural problems within their field of experience.

—Frederic H. Keyes, formerly general manager of the Robb-Mumford Boiler Co., has associated himself with Timothy W. Sprague, Henry Docker Jackson and others to carry on a general consulting engineering business under the name of Timothy W. Sprague, Frederic H. Keyes, Henry D. Jackson and associates, 88 Broad street, Boston, Mass. They propose to make complete reports, investigations, and furnish designs and supervision for all sorts of power plants for lighting, railway or industrial purposes; also mining reports, investigations and power plants.

—Frederic H. Keyes, of the office of Sprague, Keyes and Jackson, consulting engineers, Boston, has investigated the plant of the Empire Paper Co. of Ithaca, New York, submitted a report and supervised the changes necessary to improve the conditions existing at this plant.

—The Page-Storms Drop Forge Company, Chicopee, Mass., has installed a Westinghouse type J-60 gas producer plant for generating fuel gas from buckwheat anthracite to supply a 300 horse power Welbe gas engine which was formerly served by two producers of the same make. The Westinghouse gas producer is of the suction type and represents the standard design of the Westinghouse Machine Company, East Pittsburg, Pa. The plant of the Page-Storms Drop Forge Company furnishes 60 cycle alternating current for local lighting and light power operations. Lawrence Foy has been in charge of the erection of the new unit for the Page-Storms Company.

—F. H. Nickle has resigned his position as engineer for the Pennsylvania Salt Manufacturing Co. at Wyandotte, Mich., and will specialize in evaporating work and salt plant engineering. Mr. Nickle is associated with the firm of McDonald & Nickle with headquarters at Detroit.

—The American Ship Windlass Co. report that they have recently sold to the Winchester & Washington Street Railway Co., four 3-retort Taylor gravity underfeed stokers which are to be installed in pairs under 750 horse power Stirling boilers at their power station at Millville, W. Va.

—At the West Albany power station, which furnishes light and power for the New York Central car shops, there were recently added three 600 H. P. Edge Moor boilers, making a total of 3,800 boiler horse power. As in the case of the older boilers, the new ones are equipped with Taylor gravity underfeed stokers built by the American Ship Windlass Co., of Providence, R. I. In this power plant the mechanical draft for the stokers is furnished by two turbo-blower units, each consisting of a Bliss turbine and double width "squirrel cage" fans manufactured by the Massachusetts Fan Co., Watertown, Mass. In this new type of fan, which is the latest of the many-blade types, interblades extend almost to the center to set the entering air in motion gradually.

—The new factory of Stanley G. Flagg & Company, Stowe, Pa., will be supplied with power from a 300 horsepower producer plant driving a 175 kilowatt direct current generator. The engine is of the horizontal, double acting, Westinghouse producer-gas type, and develops 300 horse power by brake test. It is supplied with gas of a heat value of 125 B. t. u. per cubic foot, derived from antharcite coal. The engine is direct connected to a 175 kilowatt direct current generator, furnishing 110 volt current for lighting and power in the new factory.

NEW CATALOGUES AND TRADE PUBLICATIONS.

These catalogues may be had free of charge on application to the firms issuing them. Please mention The Engineering Magazine when you write.

Adjustable Cut-Off Engines.

RIDGWAY DYNAMO & ENGINE CO., Ridgway, Pa.—Bulletin No. 25, describing the Ridgway adjustable cut-off engine, which was originally developed for the direct driving of mine ventilating fans. It has proved itself particularly valuable for driving of ventilating fans in buildings and for connection to centrifugal pumps. For this latter duty the desirability of the adjustable cut-off gear is obvious.

Air Compressors.

NATIONAL BRAKE & ELECTRIC CO., Milwaukee, Wisconsin.—Publication No. 387, illustrating type "3 V S" motor-driven air compressors. They are of rugged construction, direct connected, of the single stage type, with three vertical cylinders, and are automatically, electrically controlled. It is claimed that the placing of the cylinders vertically permits building the compressors in the most compact form and eliminates all uneven wear on the piston and cylinder surface. All working parts are entirely enclosed, which affords protection from mechanical injury and at the same time makes it impossible for workmen or others to become caught in any of the working parts.

Arc Lamps.

GENERAL ELECTRIC CO., Schenectady, N. Y.—Bulletin No. 4717, illustrating the use of the flame arc lamp for the lighting of streets and large interiors.

Blue Printing Machine.

BUCKEYE ENGINE CO., Salem, Ohio.—An excellent description of the Buckeye electric blue-printing machine.

Bolt Nut and Forging Machines.

ACME MACHINERY CO., Cleveland, Ohio. —An extensive and well illustrated catalogue, describing a full line of bolt, nut and forging machinery.

Bolt-Threading Machines.

NEWTON MACHINE TOOL WORKS, 24th and Vine streets, Philadelphia, Pa.—Catalogue No. 46, illustrating particu-

Cement.

ALPHA PORTLAND CEMENT CO., Easton, Pa.—A very handsomely illustrated portfolio having for its aim the compilation of concise, authentic information on Portland cement for the convenience of architects, engineers, contractors, dealers and all who may have occasion to explain the advantages and uses of Portland cement in popular language.

Coal Crushers.

JEFFREY MFG. CO., Columbus, Ohio.—Illustrated catalogue of the Jeffrey standard roll coal crusher. The distinguishing features claimed are capacity, strength, efficiency and low cost of maintenance.

Concrete Mixers.

ADVANCE CONCRETE MIXER CO., Jackson, Mich.—The advantages claimed are that the mixer can be easily moved by three or four men; the low bins makes easy shoveling of materials into them; a thorough and even mix of all classes of materials; positive measurements of cement sand, crushed stone or gravel.

Concrete Mixer.

CHAIN BELT CO., Milwaukee, Wis.—Descriptive catalogue of the Chain Belt concrete mixer, a batch mixer of the non-tilting or chute discharge type, adaptable to all classes of work and capable of the largest daily output of well mixed concrete with the least labor and expense.

Conveyors.

JEFFREY MFG. CO., Columbus, Ohio.—Booklet No. 36, showing Jeffrey spiral conveyors.

Cranes.

PAWLING & HARNISCHFEGER CO., Milwaukee, Wis.—Bulletin No. 17, illustrating with much detail a line of I-beam trolleys and chain block traveling cranes. Particular attention is drawn to the I-beam trolley for circulating material of moderate weight. To install an I-beam is neither difficult nor expensive and the use of the trolleys saves trucking and skidding and leaves the floor clear for other operations.

Cranes and Hoists.

SHEPARD ELECTRIC CRANE & HOIST CO., Montour Falls, N. Y.—A handbook of hoisting machinery for industrial works, intended to present in clear and exact

form such data relative to the equipment made by the Shepard Electric Crane & Hoist Co. as will enable engineers and managers conveniently to consider the application of hoisting and conveying units to the various uses for which they are adapted and to enable them to prosecute with certainty all related engineering and construction work.

Electric Controlling Apparatus.

AMERICAN ELECTRIC FUSE Co., Muskegon, Mich.—Illustrating rheostats, motor starters, and controllers. The new method of inserting rheostats in the Allen-Bradley motor starter by means of a column of graphite discs is very interesting and should be investigated.

Engines.

BUCKEYE ENGINE Co., Salem, Ohio.—An excellent descriptive catalogue showing the Buckeye engine.

Evaporation.

MCDONALD & NICKLE, Detroit, Mich.—Pamphlet describing the McDonald & Nickle direct firing system for single and multiple effect evaporation.

Factory Fence.

ANCHOR POST IRON WORKS, 165 Broadway, New York City.—Leaflet showing many illustrations of chain-link woven steel fences with "Anchor" posts, unbreakable, unclimbable, and durable.

Fans.

WESTERN ELECTRIC Co., 463 West street, New York.—Bulletin taking up in detail the different types of fan motors offered for the season of 1910. It is well illustrated and contains valuable data and other information aside from a complete description of each of the fan motors shown.

Fuel Oil and Gas Appliances.

W. S. ROCKWELL Co., Hudson Terminal Building, New York City.—Catalogue No. 3, illustrating fuel oil burners, steam or air atomization; fuel oil pumping systems, steam or belt
tive pressure blowers, direct motor driven or belt driven.
larly multiple automatic die heads, possessing many advantages for a diversified class of work such as is found in locomotive roundhouses, repair shops, erecting shops and other manufacturing plants.

Furnace.

GEORGE J. HAGAN, 401 People's Bank Building, Pittsburg, Pa.—A neat catalogue illustrating and describing the Bailey combination furnace, which is a tandem arrangement of stoker-equipped fire box, pair heating, and sheet furnace.

Galvanized Sheet.

INLAND STEEL Co., First National Bank Building, Chicago, Ill.—"The Story of an Inland Galvanized Sheet," being an entertaining description of the manufacture of Inland extra-soft basic open-hearth galvanized sheet.

Gas Power Plants.

POWER AND MINING MACHINERY Co., Milwaukee, Wis.—An album showing Snow gas engines and Loomis-Pettibone gas generating system. Some sixtv pages of illustrations are included in it.

Generators.

WESTERN ELECTRIC Co., 463 West street, New York City.—Bulletin No. 5111, descriptive of the new design of Hawthorn type LL multipolar, engine-driven, direct-current generator. A full description of all the details of design and construction is given and the merits of the several parts are pointed out.

Heater.

AMERICAN BLOWER Co., Detroit, Mich.—Bulletin No. 273, illustrating and describing and also giving capacity table of the ABC sectional base heater for use in connection with fans and blowers for heating, ventilating and drying.

Hoisting Engines.

EXETER MACHINE WORKS, Pittston, Pa.—General descriptive catalogue of hoisting engines, electric hoists, direct and geared with cast-iron drums; locomotive cranes; bridge conveyors; industrial railways and cars; coal crushers; orange peel buckets; clam shell buckets.

Iron, Steel Machinery.

SCULLY STEEL & IRON Co., Chicago, Ill.—Catalogue of iron, steel machinery, heavy hardware, tools and supplies, supplemented with many valuable and accurate reference tables. Pocket size, flexible leather binding.

Lubricators.

DETROIT LUBRICATOR Co., Detroit, Mich.—A compact booklet of the Detroit sight-feed and plain cylinder lubricators.

Packing.

CLEMENT RESTEIN Co., Philadelphia, Pa.—General catalogue No. 3, illustrating and describing in much detail Belmont pack-

ing for steam, water, ammonia, hydraulics, oil, gases, and acids.

Power-Plant Materials.

WALWORTH MFG. CO., Boston, Mass.—A condensed catalogue of Walworth specialties, showing valves, pipe fittings and tools.

Pumps.

FORT WAYNE ENGINEERING & MFG. CO., Fort Wayne, Ind.—Descriptive booklet of the Paul pump, suitable for individual water supply systems. They are double acting, piston pumps, embodying the latest and best practice in pump design.

Pipe-Threading Devices.

TOLEDO PIPE THREADING MACHINE CO., Toledo, Ohio.—A neat catalogue describing, with many illustrations and plain text, the Toledo pipe threading devices, vises, and portable vise mounts.

Rock Crushing Machinery.

POWER AND MINING MACHINERY CO., Milwaukee, Wis.—Catalogue No. 4, giving detailed description of the McCulley gyratory rock and ore crusher. Designed to combine great capacity, durability and simplicity of construction and at the same time crush evenly and uniformly with the least possible consumption of power.

Rope Driving.

"Twenty-Five Years of Rope Driving" is the title of a very handsome illustrated catalogue of 110 pages (8½x11½ in.) issued by the Dodge Mfg. Co., of Mishawaka, Indiana, U. S. A. It illustrates and describes in detail every feature of the wide range of rope transmission work which this firm has done, in all branches of industry and in many parts of the world, and is a publication which every engineer should have in his library for reference purposes. Free upon application to Station C-12, Dodge Mfg. Co., Mishawaka, Ind.

Steam Turbines.

B. F. STURTEVANT CO., Hyde Park, Mass.—Bulletin No. 176, describing the Sturtevant steam turbine as it is now built, and enumerating the general advantages of turbine engines and the special advantages of the Sturtevant steam turbine.

Stokers.

AMERICAN SHIP WINDLASS CO., Providence, R. I.—Pamphlet showing results from tests of boilers equipped with Taylor gravity underfeed stoker in several representative installations.

Steel Poles.

FRANKLIN STEEL CO., Franklin, Pa.—Descriptive catalogue of the Tripartite steel pole, which is claimed to be stronger better, and cheaper, weight for weight, than any other metal pole. Adapated to all forms of overhead construction, whether trolley, telegraph, telephone, electric light, or power transmission.

Squeezers.

ADAMS CO., Dubuque, Iowa.—Descriptive catalogue of the Farwell squeezer, which is operated by the molder's weight instead of his muscle, making it easy to pour off a large floor at the end of the day.

Turbine Pumps.

HENRY R. WORTHINGTON, 115 Broadway, New York City.—A well arranged catalogue illustrating standard turbo-pumps designed for service where it is desired to deliver water against high heads. The uses for which they are most successfully employed are water-works service, mine drainage, elevator service, hydraulic mining, fire pumps, boiler feedings, etc.

Relative Cost of Municipal Work Done by Day-Labor and Contract, in Boston. Mass. Harrison P. Eddy. Read before the Am. Assn. for the Adv. of Sci. Gives interesting resut o ilfsnvestigations to determine the comparative cost and efficiency of the two systems. 4500 w. Eng News—Jan. 27, 1910. No. 11286.

Some Notes on Handling Men on Construction Work. Notes of experience brought out in a discussion on Halbert P. Gillette's paper on "Science of Man-agement Engineering." 3500 w. Engng-Con—Jan. 26, 1910. No. 11292.

Water-Tube Boilers.

CASEY-HEDGES CO., Chattanooga, Tenn.—Descriptive catalogue of the Casey-Hedges water-tube marine, and standard boilers, constructed entirely of open-hearth steel, there being no cast iron parts whatever about the boiler proper.

Water Weigher.

KENNICOTT WATER SOFTENER CO., Chicago Heights, Ill.—Bulletin No. 36, illustrating the Kennicott water weighers for automatic recording of weight of water evaporated by boilers, furnishing a means of continuously ascertaining the evaporative value of fuel, the efficiency of firemen, and the condition of boilers, grates, and other boiler-room equipment.

THE CURRENT RECORD OF
IMPROVED MACHINERY
NEW METHODS NEW MATERIALS
NEW APPLIANCES

Large Wood Paving Contract.

THE completion of the wood-block pavement on Market street, Philadelphia, marks the ending of one of the biggest pavement fights in the history of American cities. For the past two years, Market street has been in a state of chaos on account of the building of the subway. The merchants who are among the largest in Philadelphia had suffered severely from the conditions, both by damage to their merchandise from dirt and dust and by loss of trade.

When the time approached for a decision as to the manner in which the street should be paved, the merchants banded themselves together in an association to fight for a satisfactory pavement. Their demand for a smooth, clean and dustless pavement which would attract pleasure vehicles and pedestrians to Market street led to the

VIEW ON MARKET STREET, PHILADELPHIA.

elimination from consideration of all types of pavement except wood block and asphalt. For a time, asphalt was the favorite, because wood block had never been tried in Philadelphia and its merits were not understood. The merchants' association, however, made a thorough investigation through a committee which visited various cities to examine the leading types of pavement, and also through the employment of experts who prepared an elaborate report for their information. As the merits of wood pavement became better understood it became more popular.

Market street is one of the broad central thoroughfares of Philadelphia. It is sixty-one feet in width, and the part which was to be re-paved ran from the Schuylkill River to Delaware street. At each end was a section where the grade was too steep for a smooth pavement. The area that was paved with wood was 85,000 square yards, which made the largest single contract for wood block paving that has yet been let in this country.

It is the belief of the promoters of this pavement that in quality this job reaches the high-water mark and that Market street now has the finest pavement that has ever been laid in an American city.

The foundation is six inches of concrete. Many of the New York city pavements are laid on four inches of concrete and are considered satisfactory. The extra two inches, however, makes it certain that there will be no changes of contour through the settling of the foundation. A one-inch sand cushion was spread over the concrete and the block laid thereupon with the grain of the wood vertical and grouted with cement after being rolled into true contour by a ten-ton roller.

The wood which was used was long-leaf yellow pine. After thorough seasoning, the wood was put in a cylinder, heated, and subjected to a vacuum treatment which removed all moisture and sap from it. Creosote was then admitted into the cylinder and injected into the blocks by great pressure until the blocks had absorbed all the creosote that they would take up. This treatment carries creosote clear to the heart of the block, destroying all organic life and making decay absolutely impossible. The blocks used on the Market street job were four inches in depth as contrasted with the three- and three-and-a-half-inch blocks frequently used elsewhere.

What the life of this pavement will be is problematic. It is certain, however, that it will last much longer than any other pavement that has ever been devised, not excepting granite blocks.

The traffic on Market street is very heavy and has greatly increased since the new pavement was laid. The effect of traffic on the blocks, however, is practically negligible. The end of the fibre of the wood will be compressed slightly and matted down, obliterating the joints. This will take about four months, after which there will be no further deterioration.

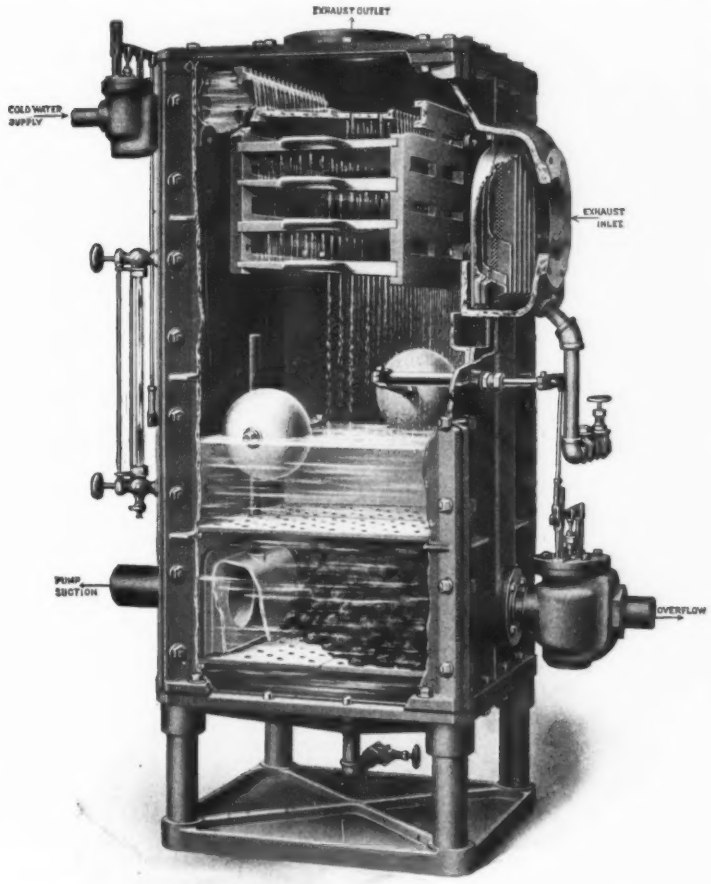
The concrete foundation will grow stronger with age, and the wood will grow harder the longer it is pounded. On account of the elasticity of the wood, there will be no pulverization, as with stone or asphalt. The fact that the subway underneath carries pipe galleries, makes it certain that the street will not be disturbed for excavations, so that this source of future damage is probably safely disposed of. The price of the pavement was $3.49 per square yard and the contractor was Edwin H. Vare of Philadelphia.

The Blake-Knowles Open Feed Water Heater.

THE accompanying illustrations show an improved type of open-feed water heater which the Blake & Knowles Steam Pump Works has recently put on the market. This heater is of new design and combines in its construction all the points of advantage that the "open" method of heating boiler feed water, or water for heating or drying systems, etc., allows over other methods

ordinarily in use, and embodies other features of convenience and economy of operation.

In this apparatus the water is heated by direct contact with the exhaust steam, the heating capacity of which is utilized at its maximum degree, and there is no drop in the temperature at which the water leaves the heater, due to any collection of mud or scale. All impurities in the water, such as sand, floating particles, etc., are retained in the filter and all scale forming carbonates, air and other gases, so dangerous to the life of boilers, are removed, making the product leaving the heater, pure, hot water, perfectly suitable for boiler feeding or other refined industrial purposes.



BLAKE-KNOWLES OPEN FEED WATER HEATER.

This heater combines in one apparatus the functions ordinarily performed by several machines. It extracts all the oil from the incoming steam, and besides

heating the water, it filters and purifies it. It contains also a storage tank for receiving the water of condensation. While all these functions are combined in one apparatus, its operation is so simple and so automatic that but little attention is required on the part of the engineer.

This apparatus consists of a vertical, cast iron, rectangular shell, on one side of which, near the top, is located the exhaust steam inlet. The oil separator is built into the heater body just inside this inlet and all the steam must pass through this separator before it can enter the heater. Inside the heater shell, at the top end, several shallow, removable, water trays are arranged, one beneath another, which are slightly inclined and partly perforated. Above these trays, on the opposite side from the steam inlet, is the cold water inlet trough, out of which the water supply, conducted through an automatically controlled valve, is spilled onto the trays. The filter is located at the lower end of the shell, the material of the filter bed consisting of coke, excelsior or other similar material. This material is confined between two perforated plates, and when necessary can be removed through doors provided for the purpose. Beneath the filter bed is a chamber from which the purified water is taken away by the feed pump. All the sediment collects in the lower part of this chamber and is drained away through a blow off connection to waste. The receiving chamber occupies the space above the filter bed and is of extra large capacity, so as to take care of the condensation from heating systems, etc., which is received in deluges from the traps, pockets, radiators, etc., when they discharge their contents. An automatically controlled overflow, at the top of the receiving chamber, takes care of any dangerous excess of water and this overflow extends the full width of the shell and forms a "skimmer," so that floating impurities can be "skimmed off" by simply holding open the cold water inlet valve until the heater fills to this point, when the impurities run off into the overflow and through the valve below, to waste. The feed pump suction is located at one side of the feed water chamber with a vent pipe leading up into the heater body for carrying away any vapors that may collect. An outlet is located at the top end of the heater shell, which is used as exhaust outlet or vent pipe, as required, depending on whether the apparatus is used as a "thoroughfare" or "draw" heater.

In operation, all or part of the exhaust steam, as may be required, enters the exhaust inlet, where, moving at a high velocity, it strikes a peculiarly punctured and bent metal surface. The elastic steam rebounds and passes around to either side, while the oil, on account of its greater momentum, is carried through the punctured sheet against the back plate of the grating, where, out of the swirl of the steam current, it falls into the receiving well and drains away to waste. The oil cleansed steam now enters the heater shell and fills the space around the trays where it comes into intimate contact with the water supply which is dropping from tray to tray in a finely divided condition. The water supply, entering through a float controlled valve, fills the distributing trough which extends across the shell and overflows from a serrated edge in a thin, even sheet onto the trays below. These trays, arranged one below the other, are slightly inclined and partially perforated so that the water flows from one to the other over the lower serrated edge of each and through the perforations, being retarded in its progress so that it is thoroughly mixed with the steam before falling into the hot well below. Ample space is allowed around the trays so that the water in its finely divided state is heated to the highest possible temperature.

The difference in height between the normal water level in the hot well and the overflow level is sufficiently great to accommodate the sudden inrush of water

from the traps, returns, etc., forming in this way an adequate storing chamber for the water thus received.

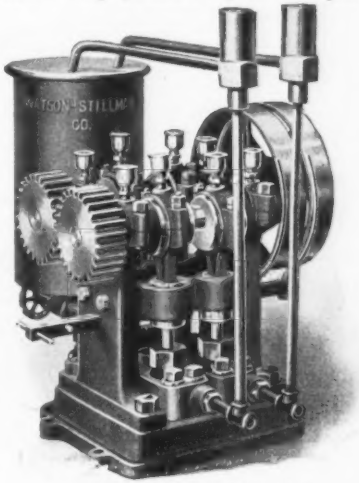
Two floats, properly located in the receiving chamber, automatically control the operation of the apparatus; one, connected with the water inlet valve, regulates the cold water supply and maintains a constant water level, at the same time meeting the demands of boiler feed water supply, while the other, connected with the overflow valve, opens this valve when the overflow level has been reached and allows the excess water to escape to waste.

The water and condensed steam, after falling to the receiving chamber, percolate slowly through the filter bed and in this process, due to the heat of the water and the special design of the heater, the scale forming carbonates in the water are precipitated and retained by the filtering material while the gases liberated pass out with the uncondensed steam through the vent pipe at the top of the heater. The purified and heated water drops into the settling chamber and is pumped away, a pure, hot water, free from mud and scale-forming matter, in perfect condition for boiler-feed use. The heavy sediment collects at the bottom of the chamber and is drawn off when necessary through the blow-off connection below the heater body.

As will be seen from the above, the operation of the apparatus is entirely automatic and, under ordinary circumstances, requires no attention whatever. An occasional cleaning, as may be needed from time to time, and such inspection as every engineer gives to all parts of a plant in his charge are all that are required. Every convenience is provided for this purpose and no pipe joints have to be broken for any of the operations necessary. Pressures ranging from atmospheric pressure to five pounds above may be carried in the exhaust line without impairing the efficiency in any way and without requiring any modification in the construction or operation of the heater.

A Small Powerful Hydraulic Pump.

THE four-cylinder two-pressure-line hydraulic pump illustrated represents a new Watson-Stillman type by means of which one, two, three or four pressure lines may be served independently of each other, but from a common reservoir. Each pressure line has a separate pressure chamber, safety valve and release line and is served by a separate pair of cylinders (one-half inch diameter by one-half inch stroke) having eccentrics set to give a continuous flow. Any pressure up to 600 pounds



SMALL HYDRAULIC PUMP.

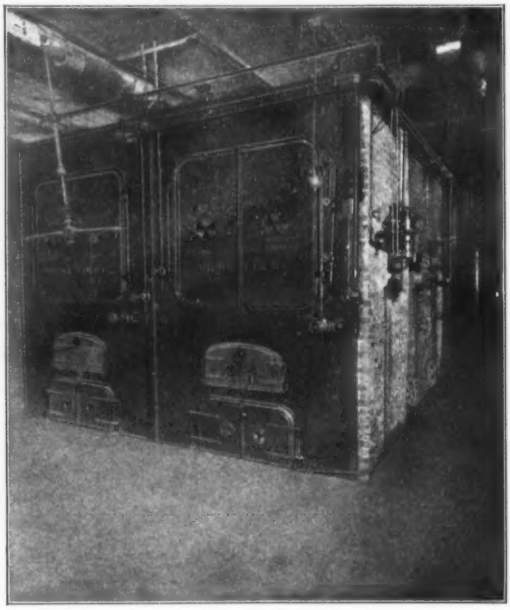
per square inch may be delivered into any line, the limit in each instance being determined by the setting of the safety valve, which opens as the pressure tends to exceed the limit and lets the surplus liquid pass back through the release pipe to the reservoir. Any pressure line can be thrown out of service entirely by opening the safety valve, in which instance all the liquid in that line pumps directly back to the reservoir.

The one-, two-, three-, and four-pressure-line pumps are practically the same in design save for change in the length of the bed plate and the shafts to accommodate the required number of pressure

chambers, cylinders, piston rods, eccentrics, etc., and may be fitted with an electric motor instead of the pulley shaft shown. These pumps are made by the Watson-Stillman Co., of New York.

The Wing Turbine Blower.

THE distinguishing feature of the "Typhoon" turbine blower is its combination of an up-to-date steam turbine with a rotating fan of the helicoid type, occupying unusually small space, the latter being a point of special importance in large cities where space is valuable. It is driven by direct steam connection from the boiler and takes the place of the time-honored belt, or engine-driven fan and the aspirator or steam jet.



WING BLOWER AT PLANT OF U. S. PLAYING CARD CO.

The accompanying illustration shows that the combination produces a compact, and at the same time highly efficient unit. The nozzles are held in the hollow cored steam chest with its half-inch steam inlet. The steam impinges directly upon the buckets which are cast by a special process into a bronze ring to which is fastened the fan proper. The bearing consists simply of a bronze bushing rotating on the fixed hollow steel shaft the end thrusts being formed of steel surfaces. A cap screwed over the hub of the fan makes the bearing dustproof, and a cast iron casing enclosing the whole rotating element affords complete protection.

As shown by the attached drawing, the blower may be placed directly in the boiler wall, thereby saving floor space, giving separate boiler control and doing away with supplies, repairs and constant attention. Operated automatically by the damper regulator, the "Typhoon" turbine blower gives a unit which is capable of great flexibility, whose steam consumption is exceptionally low and whose broad range of air

delivery and pressure enable all low-grade fuels to be properly and efficiently burned, giving at the same time a marked increase in the capacity of the boiler.

The blower is made in four sizes, namely, 12, 16, 20 and 24 inch, suitable alone or in combination for any size boiler. The latest bulletin No. 6 gives complete details of the "Typhoon" turbine blower system for mechanical draft. Further information relating to this interesting system may be obtained from the L. J. Wing Mfg. Co., 2111 West Street Building, New York City.

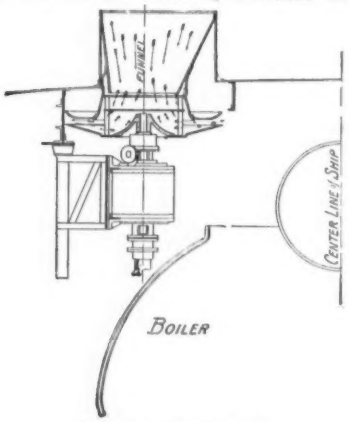
Vertical Turbo Fans for Forced Draft.

THE 50-H. P. seven-stage vertical turbo-fan which we illustrate is one of eight designed by the Kerr Turbine Co., of Wellsville, N. Y., for supplying forced draft to the boilers of the U. S. torpedo boat destroyers Sterrett and Perkins. These turbo-fans operate at a maximum steam pressure of 265 lbs. and non-condensing against 5 lbs. back pressure. The fans, of the American Sirocco type, are placed to take air from the outside through funnels on the deck and discharge it into the fire room through adjustable cone-shaped casings. Two fans each operating at 1,655 R. P. M. deliver 40,000 cubic feet of free air per minute into each engine room maintaining within a pressure equivalent to four inches of water. The installation arrangement is shown in the line diagram. The turbines are made right and left and are arranged in pairs, one pair delivering into each fire-room. One unit is bolted directly onto a vertical stanchion on each side of the boiler. It is evident from the diagram that the space restrictions are quite severe. Small diameter of the turbine is an important requirement and this was made possible without reducing the power below the desired limit, only by using seven rotors, each 12 inches in diameter. The use of many stages with light rotors of small diameter in these turbines also overcomes trouble from gyroscopic action better than using fewer rotors of larger diameter. Experience has shown that in marine work the gyroscopic action of large heavy turbine wheels running in a horizontal plane and with bearings close together subjects the bearings to heavy side pressure as the boat rocks. The effect of gyroscopic action is made negligible with the smaller wheels and is further minimized in these Kerr turbines by the comparatively long distances between the bearings.

VERTICAL TURBO FAN FOR FORCED DRAFT.

Kerr turbines have met with great favor for driving electric generators on shipboard and for driving marine auxiliaries because of their economy, compactness, reliability and the absence of oil from their exhaust. A turbine is always clean in appearance and seldom requires attention. The test economy is maintained indefinitely, as there are no internal parts to rub and wear. This is

of special advantage in driving fans and pumps where the grinding of dirt and cinders on the rubbing surfaces of a



VERTICAL TURBO FAN.

reciprocating unit would render more attention necessary.

Efficiency of a Harrison Aertube Heater.

IN a test recently made by M. F. Thomas in trying out several different types of oil burners some interesting figures were obtained regarding the efficiency of the Harrison Aertube heater, manufactured by the Harrison Engineering Co., New York City. These tests were not run to determine the efficiency of the heater, and therefore no attempt was made to get exceptionally good rsults. The Aertube heater is made up of 4-inch cast-iron tubes connected at each end into headers and placed over the furnace in which the fuel is burned, the hot gases passing among the tubes, through which the air for heating is forced by a fan. The heater tested consisted of four sections of 32 tubes each, making a total heating surface of 547 square feet, the tubes being 48 inches between tube sheets.

The air for the oil burners was supplied under a pressure of 17.3 ounces per square inch, and the oil pressure was about 14 ounces per square inch. From the heater tubes the air was exhausted by a 110-inch steel plate fan operating at about 250 revolutions per minute. The velocity of the air was measured by an anemometer placed in a casing around the inlet side of the heater. It entered with an average temperature of 74 degrees, and was discharged from the heater at 120.7 degrees, the rise in temperature being 46.7 dgrees.

The results of the various computations may be summarized as follows:

Volume of air at 74 deg. = 23,350 cu. ft. per min.

Rise in temp. 74 to 120.7 = 46.7 deg. F.

Heat deliv. $= \frac{23350 \times 46.7}{56} = 19470$ B.T.U. per min.

Oil consumed per min. (at 7.00 lbs. per gallon) = 1.13 lbs. per min. and at 19,470 B.T.U. per min.

Heat supplied = $1.13 \times 19470 =$ 22300 B.T.U. per min.

Eff. $= \frac{19,470}{22,300} = .872 = 87.2$ per cent.

Rate of heat transfer $= \frac{19470 \times 60}{547}$ = 2135 B.T.U. per sq. ft. per hr.

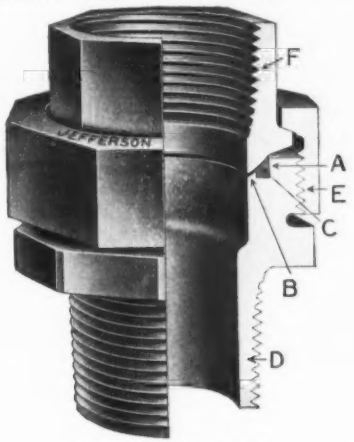
Ave. veloc. of air through tubes computed from mean temp. = 2,335 ft. per min.

In commenting on this test Mr. Thomas stated that the ultimate efficiency should have been higher than the figures given here because the temperature was increasing slowly at the time the readings were made.

The Jefferson Union.

EVERY practical steam fitter knows well enough that with a male and female union he can save a nipple, avoid an extra joint, and do the job in two-thirds the time with more than double the assurance that it will stay tight. What is more, he can make a good deal shorter connection; this counts for much where there isn't an inch to spare. The Jefferson Union, made by the Jef-

ferson Union Co., Lexington, Mass., is a new style male-and-female union, built on the Jefferson principles,—a spherical, ground, brass-to-iron joint. A brass ring forms the seat or contact. It is firmly embedded in a channel in the part having an external thread. All the rest of the fitting is of malleable iron. The ring A is of wrought metal, cut from seamless brass tubing,—there is no



THE JEFFERSON UNION.

chance for the blow holes so common in cast brass. The brass-to-iron joint is used because it is non-corrosive. It is a matter of common knowledge that with temperature changes, brass expands or contracts more than iron, and that this difference tends to leave an opening between the two metals. Such a small amount of brass expands and contracts less,—but enough is used to do the work. The iron wall B absorbs the heat, distributes it through the iron, so that much less reaches the brass than in any other make, in which the brass is in direct contact with the fluid. It protects the brass from injury, no matter how far the pipe is screwed in. It makes the ring practically one piece with the iron, so that it cannot become dislodged. No gasket is used, this means a saving in time and expense. There is plenty of play for the part F, which swivels in the nut, so that it is easy to make a tight connection even though the pipes are not in perfect alignment. The brass ring is cut at G to fit the spherical end of the opposing member. The two parts are then ground together.

Without sacrificing any desirable feature, the Jefferson style "F" is as short as any male and female union on the market. Consequently it can be used for short connections where the ordinary union and nipple would be impossible. But short as it is, any style wrench with any width face may be used on any of the three parts. The octagon flats of all three parts are so arranged that there is no intereference. On the clamping nut the flats are outside, clear of the corners of the part D having the external thread. On the part D, the flats are outside and clear of the nut threads.

Sturtevant Dust Blowing Set.

FOR blowing dirt and dust out of machinery and from around motors, switchboards, shelving, and other places difficult or dangerous of access, the B. F. Sturtevant Company, Hyde Park, Mass., has brought out a new portable dust blowing set. The device is electrically driven and weighs only 55 lbs. It is easily portable and is adapted for attachment to lighting sockets, so that the range of its usefulness in a manufacturing plant or elsewhere is very broad.

While the blower does not give as high a pressure as the large compressed air systems, the larger volume of air accomplishes in most cases the same purposes with the hard, severe blast. There is an additional advantage derived from the larger volume of air in the speed with which the work is accomplished.

The set includes a 12-ft. length of 1¼ in. flexible reinforced air hose and 10-in. tapered polished aluminum nozzle. A 20-ft. electric light cord is furnished and in combination with the hose gives a working radius of 32 ft. from a lighting socket.

As a vacuum cleaner the set may also

be employed for suction cleaning where a dust collector is not necessary. For this work one end of the hose is attached to the inlet of the fan, while the vacuum cleaner tool is attached to the other. The fan will suck the dust through the wheel and discharge it at the outlet or through the hose connected thereto which is led out of doors.

Bulletins describing the sets may be secured by addressing the Sturtevant Company either at Hyde Park, Mass., or any of their branch offices.

Automatic Hollow Chisel Mortiser.

THIS new automatic horizontal hollow chisen mortiser is designed for a great variety of light and medium grade of work in car and bridge construction. The capacity of the machine is 8″ wide by 8″ thick and it will mortise from ¼″ to 1½″ square and to the depth of 7″. The manufacturers claim special merit for this machine because of its convenient adjustments. The reader will note

AUTOMATIC HOLLOW CHISEL MORTISER.

from the illustration that all the adjustments are within easy reach of the operator. In the manufacturer's new illustrated circular special attention is called to the following features:

The column is a single cored casting, very heavy and with broad, continuous floor suport. The table is 40″ x 8¾″, is counterbalanced, and has vertical adjustment of 8″ by means of a lever provided with stops to permit of making double or triple rows of mortises in same line. It has an adjustment endwise, with suitable stops for regulating the length of mortise by hand wheel, rack and pinion. The chisel is fixed to a reciprocating frame moving in planed ways on the top of the column. It is driven by elliptic gears and has quick return at the completion of the mortise. There are three speeds of feed to the ram to cover a wide range of sizes in chisels and hard and soft woods. The foot treadle at the base of the machine governs the chisel thrust. The stroke of the chisel is variable by changing the crank pin on the crank arm. The depth of mortise is regulated either by the adjustment of the table or the adjustment of the stroke.

For further information regarding this machine write the manufacturers, J. A. Fay & Egan Co., 212-232 W. Front St., Cincinnati, Ohio, who will be pleased to send you their illustrated circular.

Industrial Notes.

—The Globe Stove and Range Co., Kokomo, Ind., have largely increased their plant and have installed a Newten cupola of 14 tons hourly capacity and an outfit of ladles and trucks for industrial railway, all furnished by the Northern Engineering Works of Detroit. James Brady Foundry Company have recently increased their plant and have installed their second 3-motor alternating-current electric Northern traveling crane of 10 tons capacity, 41-foot span.

—The Power Specialty Co., New York, have removed their Chicago office from The Rookery to the Peoples Gas Building in order to have better accommodations for handling an increased business. The office is in charge of Mr. R. B. Nutting, manager, and Mr. R. H. Wyld, assistant manager. The volume of Foster superheater sales is increasing rapidly, the contracts secured so far this year nearly equaling the total of last year's business.

—The Industrial Supply & Equipment Company, 407 Sansom street, Philadelphia, have secured the contract to build a single-track steam railroad between Roswell and Tucumcari, N. M., to be known as the Roswell, Northern & Gulf Railroad and will cover a distance of about 146 miles. The Industrial Company is now receiving bids for the construction work and equipment.

—Geo. W. Cravens, 547 West Jackson boulevard, Chicago, has decided to devote all of his time to industrial betterment, the mechanical and electrical design and development of special machines and new devices.

—Boiler owners are realizing more and more the waste and expense due to impure feed water that scales and corrodes feed-water heaters, piping and boilers, in addition to the enormous waste of fuel. Wm. B. Scaife & Sons Co., of Pittsburgh, Pa., manufacturers of the Scaife and We-Fu-Go water softening and purifying systems, report an unusually large volume of business. Among some of their recent orders for the Scaife and We-Fu-Go systems are the following: American Sheet & Tin Plate Co., Vandergrift, Pa., 15,000 h. p.; Auburn & Syracuse Electric Railway Co., Auburn, N. Y., 750 h. p.; River Furnace & Dock Co., Cleveland, Ohio, 6,000 h. p.; Capac Paper Co., Capac, Mich, 600 h. p.; The Pocasset Worsted Co., Thornton, R. I., 1,000 h. p.; Spencer Kellogg & Sons, Buffalo, N. Y., 1,500 h. p.; New York & New England Cement & Lime Co., Hudson, N. Y., 8,500 h. p., all of the We-Fu-Go System; Continental Fibre Co., Newark, Del., 250 h. p.; Galena Smelting & Mfg. Co., Galena, Kansas, 150 h. p., Scaife Automatic System.

—A large gathering of Cincinnati's prominent business men took place at the new plant of the Triumph Electric & Ice Machine Company on April 30. The occasion marked the formal opening of this company's new and greatly enlarged plant. About 500 guests representing the Business Men's Club, the Chamber of Commerce, the Manufacturers' Club, the Cincinnati Industrial Bureau and the Cincinnati Metal Trades Association were conveyed to and from the plant by a special train.

—Of interest to the electrical trade is an announcement just made concerning the Cutler-Hammer Mfg. Co. of Milwaukee, makers of electric controlling devices, and Kohler Brothers of Chicago, contracting electrical engineers and owners of the patents covering the Kohler system automatic, push-button control for printing presses, motor-driven tools, etc. An arrangement has been made by the two companies in question whereby the Cutler-Hammer Mfg. Co. will hereafter manufacture and market for Kohler Brothers, in the United States and Canada, the various types of push-button-operated controllers comprised in the Kohler system of control. It is announced by the Cutler-Hammer Company that they have retained the services of the men who have been handling this branch of Kohler Brothers' business, thus insuring a continuance of expert supervision by engineers thoroughly familiar with the Kohler system control and its application to printing presses and other classes of motor-driven machinery.

—The Walter Baker Chocolate Co., Milton, Mass., are building a new refrigeration room designed by F. W. Dean, mill engineer and architect, Boston, Mass. In this factory there is a central ammonia absorption refrigeration plant where brine is cooled to 10° F. and circulated to bunker rooms in various parts of the plant. Here air is forced around pipe coils containing the brine and circulated by fans through the cooling rooms. In the addition now being built a motor-driven squirrel-gage fan made by the Massachusetts Fan Co., of Watertown, Mass., is being installed for the air circulation in the bunker rooms.

NEW CATALOGUES AND TRADE PUBLICATIONS.

These catalogues may be had free of charge on application to the firms issuing them. Please mention The Engineering Magazine when you write.

Boiler-Room Economy.

An illustrated reprint (second edition) of the very instructive lecture delivered before the International Association for the Prevention of Smoke, by Mr. Paul M. Chamberlin, M.E. Pointing out the great advance that has been made in steam-engine economy and boiler design, Mr. Chamberlin directs his attention specifically to the theory of combustion, and the great economies made possible by the installation of mechanical stokers. The paper is replete with diagrams and certified records, and because of the valuable data presented the lecture will be prized by engineers interested in problems of fuel economy and smoke prevention. Free on application. Underfeed Stoker Co. of America, Marquette Building, Chicago, Ill., U. S. A.

Cement.

Alpha Portland Cement Co., Easton, Pa.—A very handsomely illustrated book, comprising concise and authentic information on Portland cement for the use of architects, engineers, contractors, dealers, and all who may have occasion to explain the advantages and uses of Portland cement in plain language.

Corliss Engines.

A very handsome bulletin of 24 pages (7 x 10) beautifully illustrated and presenting with scientific accuracy all the details of the vital improvements which have been made in recent years in the Wisconsin-Corliss engine. Jealously maintaining their reputation as builders of "the highest grade" of standard Corliss engines of all types, this company has introduced improvements which make possible a rotative speed up to 175 r.p.m. "with less friction, wear, and noise, than that of other gears of ordinary speeds up to 100 r.p.m." The publication is in fact a valuable treatise on improvements that have been achieved in engine construction during recent years, and it will well repay the careful reading of power-plant engineers. Free on application. Wisconsin Engine Co., Wisconsin, U. S. A.

Dust Blowing Set.

B. F. Sturtevant Co., Hyde Park, Mass.—Leaflet describing a dust-blowing set composed of a small and light aluminum fan driven by a direct-connected electric motor, built to operate from lighting circuits. Designed for blowing out dust from around motors, switch-boards, textile or other machinery, and from other places either difficult to get at or dangerous to handle.

Gas Compressors.

Ingersoll-Rand Co., 11 Broadway, New York.—While the compression of gas for transmission purposes may be said to be of comparatively recent date, yet the fundamental principles of gas-compressor design are the same as those of air-compressor design. The Ingersoll-Rand Co. brings an experience of thirty-nine years devoted to the building of air and gas compressors and pneumatic machinery. An interesting little catalogue.

Piping.

Harrison Safety Boiler Works, Philadelphia, Pa.—Leaflet No. 5, illustrating fifteen solutions of a problem in connecting up an exhaust steam-heating plant under certain conditions.

Road-Making.

Barrett Mfg. Co., 17 Battery Place, New York.—An interesting catalogue, entitled "Good Roads; How to Build, Preserve and Make Them Dustless," by the application of Tarvia, a specially prepared coal tar material. Contains much information of interest to those who have to do with road building or maintenance.

Turbines.

J. & W. Jolly, Holyoke, Mass.—A well arranged catalogue of McCormick-Holyoke turbines. In addition to the descriptions of the machines and many reports of efficiency tests there are included a number of formulæ and tables of unusual value in calculating flow of water, etc.

Munson Bros. Co., Utica, N. Y.—An illustrated pamphlet of the Phœnix "Little Giant" turbine water wheel. By use of the division plate in this wheel, one-half of the wheel and one-half of the quantity of water may be used with very little loss in percentage of power. The wheel is double, the lower part being independent of the upper, and both keyed to the same shaft—or two wheels with their backs together on the same shaft, one discharging downward and the other upward.

THE CURRENT RECORD OF
IMPROVED MACHINERY
NEW METHODS NEW MATERIALS
NEW APPLIANCES

Bristol-Durand Averaging Instrument.

THE Bristol Company, of Waterbury, Conn., have for the last twenty years made a specialty of manufacturing automatic recording instruments for pressure, temperature, and electricity. As this class of recording instruments using circular charts have come into general use, there has developed a demand for a simple device, to determine quickly the average of the record made on such charts, and the integral value for the whole twenty-four hours or for the time covered by the record. This demand has been filled by the instrument illustrated herewith, which is based upon a fundamental plan as worked out and patented by Prof. W. F. Durand of Stanford University, and is constructed in accordance with a design recently patented by Wm. H. Bristol, president of the Bristol Company.

BRISTOL-DURAND AVERAGING INSTRUMENT.

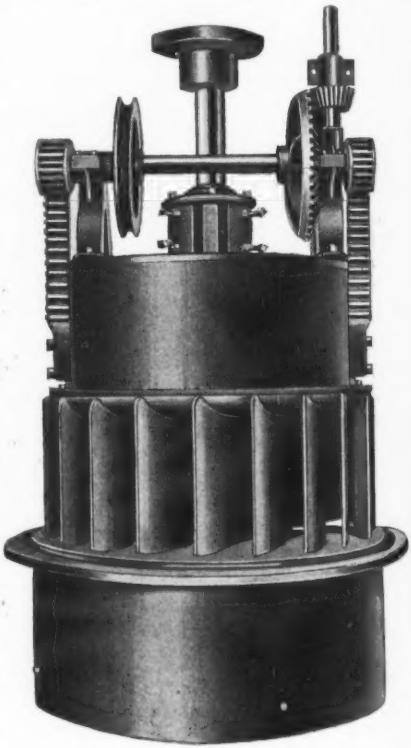
The instrument can be applied for averaging records of any kind on circular charts having uniform graduations, as, for instance, records of watts, amperes, temperature, pressure, etc. Recording instruments equipped with circular charts are therefore made available for a number of applications for which it was previously thought necessary to use the instruments recording on straight lines or strip record charts. Recording differential pressure gauges are coming into use for measuring velocities and volumes of liquids, air or gas flowing in mains, and this integrating device will prove of value for obtaining quickly total volumes of flow for any given period of time.

The construction of the instrument is shown in the accompanying illustration. A wooden base with a metal socket is provided for supporting and centering the chart. The socket holds a rotatable pin with a vertical slot at the top to receive the bar which carries the integrating tracer point and triangular support. The vertical groove in the rotatable pin allows the integrating wheel to roll on the chart with uniform pressure due to its own weight. The integrating wheel is six inches in diameter, the rim being graduated into one hundred numbered equal spaces, and is fitted with a vernier, which makes is possible to read easily with the naked eye to one-tenth of one division on the integrating wheel. The wheel is of such large size it is not necessary to supply any counting device for the number of revolutions. The number of complete revolutions cannot be more than two, even for a record of maximum size on the large 12 in. charts.

To operate the instrument the thumb and forefinger of one hand are applied to the base of the triangular support, which is moved radially so as to cause the tracer point to continually follow the record curve, while the chart is turned with the other hand. By referring to a line plotted on a sheet of cross section paper furnished with the instrument, for the particular record curve that is to be measured, the total reading for the entire twenty-four hours may be taken off directly.

McCormick Holyoke Turbine.

THE accompanying illustration shows the McCormick Holyoke turbine manufactured by J. & W. Jolly, Holyoke, Mass. In the year 1888 the firm of J. & W. Jolly took up the manufacture of turbine water wheels with John B. McCormick, who has been aptly designated "the man who revolutionized the turbine wheel business of the world," and is today recognized among water wheel



M'CORMICK HOLYOKE TURBINE.

builders as understanding the action of water in passing through the wheel better than any living man, holding the same position in regard to the designing of water wheels that Nat Herreshoff does to the designing of yachts. During the period from 1888 to 1894 John B. McCormick made for them a complete set of master patterns ranging from 9 inches to 66 inches in diameter (the only set in existence), which were his final triumph, being from 10 to 25 per cent. greater in power as to diameter than his previous effort. They stand to-day in the forefront of all other water wheels for efficiency, no wheel being put on the market until it had exceeded 80 per cent, efficiency in the Holyoke Water Power Company's testing flume, some attaining an efficiency as high as 85 and 86 per cent.

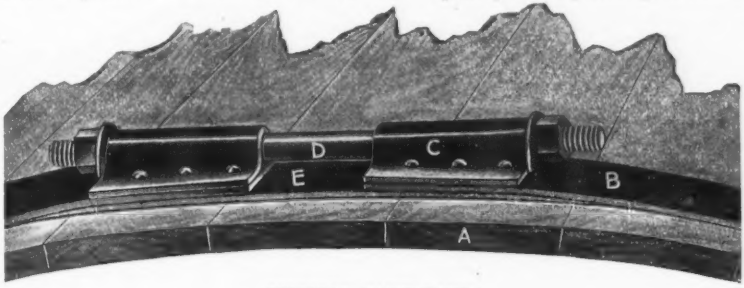
The highest compliment paid to Mr. McCormick is the fact that the leading water-wheel builders of to-day are copying his designs as closely as possible, but none have been able to reproduce those curves in which the true secret of their high efficiency lies.

In a very neatly arranged catalogue J. & W. Jolly reproduce copies of original tests made from these wheels in the Holyoke Water Power Company's testing flume and draw attention to the fact that in every case the tests exceed the tabled power of the wheel.

To meet the demand for direct connection to electric generators they have designed a number of special wheels of high speed and power and the catalogue referred to shows what has been done along these lines. The tests show that they are in a particularly favorable position to design wheels to meet special requirements for modern electric plants, where high speed and power, combined with economy of space, are of vital importance.

Corcoran Tank Band.

THE attached illustration shows plainly the tightening device used on bands for wooden tanks as made by A. J. Corcoran, Inc., 15 John street, New York City. A riveted band can not be placed exactly where it will do the most good, as it must be driven down until it binds, when it may be several inches below the point where it is most needed to give retaining strength to the tank. The Corcoran bands are tightened by means of lugs on each end, through which a bolt or draw rod is passsed, as shown in the illustration. An anti-friction plate is placed between the lugs and the tank, enabling the ends of the bands to slide readily together without injury to the staves. Not only do these lugs make it possible to keep a tank always tight without trouble, but they also make it possible to place the bands upon the tank exactly where experience teaches that the greatest strain will come. For larger sized tanks the bands have several pairs of lugs. By the aid of a wrench the nuts are turned and the space between the ends of the



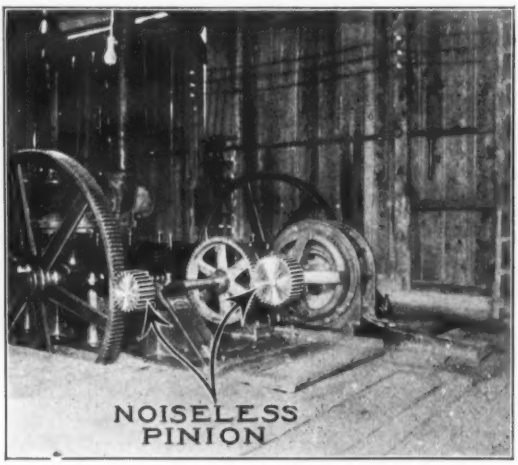
CORCORAN TANK BAND.

bands lessened, taking up all shrinkage of the wood and making the tank as tight as a water pail. As the joints of the band can be placed in position to suit the requirements of the work in hand the superiority of this method is apparent when contrasted with the old style of riveted hoop, which must be forced into place all around the tank. This is often difficult, and sometimes impossible. A. J. Corcoran, Inc., 15 John street, New York City, publish a pamphlet "As Tight As a Water Pail," which gives some very interesting information regarding the construction of wooden tanks for all purposes. They will send a copy on request.

Rawhide Pinions on Metal Drives.

RAWHIDE pinions are usually considered merely as a means of stopping noise on medium and high speed drives, and by far the largest percentage of them are used for that purpose. It is a matter of engineering experience, however, that rawhide is quite beneficial on gear drives where there is vibration from irregular load, etc. This is well illustrated in the instance of the 1,750 gallon quintuplex pump in the power plant of the Parral Power & Reduction Co., Parral, Chihuahua, Mexico. This pump, as shown in the illustration, is geared through double reduction to an induction motor and furnishes the circulating water for the condenser.

Originally it was driven entirely by cut steel pinions and cast iron gears. The pump was of so light a pattern that there was considerable spring in both shaft and frame. The result was constant annoyance from broken gear teeth, and in addition to gear renewals there was quite an expense due to the power loss of running the engines non-condensing while pump repairs were being made. The chief engineer had about decided to abandon the pump and replace it with another of different design when someone suggested the use of rawhide pinions. Accordingly, four pinions made by the New Process Raw Hide Co. of Syracuse, N. Y., were substituted for the four steel pinions. Two of these are shown in the photograph, one on



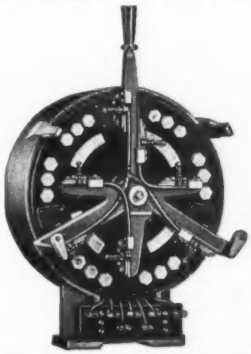
RAWHIDE PINIONS ON METAL DRIVES.

the motor and the other meshing with the big gear at the left. The other two are on the other side of the motor and placed symmetrically to those shown. These rawhide pinions were put into service over two years ago and there has not been a moment's trouble with the gearing since. In fact the pump has been out of service only long enough to repack the plungers and replace the rubber valves.

When properly cured and machined rawhide makes up into a gear or pinion that is much the same as metal, except that it has no metallic ring and is more elastic. This elasticity is highly advantageous on motor and other drives, in that it absorbs the shock as large gear teeth come into contact and as cutting tools come into cutting contact, and it cushions the irregularity of load due to the reciprocating movement of parts in machine tools or gear powered plant apparatus.

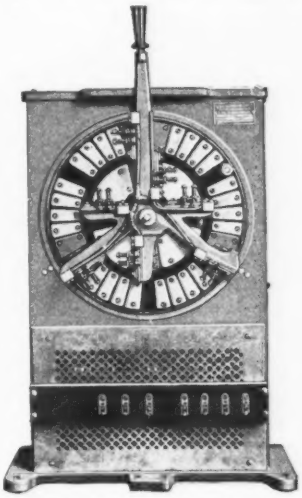
Alternating Current Controllers.

UNTIL quite recently direct current motors were used almost exclusively for operating electrically-driven cranes and mill machinery. However, the flexibility and ease with which alternating current may be transmitted has, within the past few years, resulted in a large and increasing use of alternating current motors for these applications. For this character of work the series



ALTERNATING CURRENT CONTROLLER.

wound direct current motor has the very desirable characteristic of high starting torque. In alternating current motors this feature is more nearly found in the slip ring type of motor than in the squirrel cage type. Therefore for the operation of cranes, mill tables, and other reversing work of a similar nature, the



ALTERNATING CURRENT CONTROLLER.

development of the alternating current motor has leaned heavily towards the use of the slip ring motor. Speed and torque control are obtained by inserting and varying resistance in the secondary winding of the motor.

The Electric Controller & Manufacturing Company of Cleveland, Ohio, has developed a comprehensive line of manually operated controllers for slip ring alternating current motors from 1 to 100 H.P. These controllers follow as closely as possible in design and construction, the direct current controllers which this company has been manufacturing for years. In fact, wearing parts on the A. C. and D. C. controllers are interchangeable to a large extent.

The controllers illustrated are for use in connection with reversing slip ring motors, either 2-phase or 3-phase. The

resistance is entirely self-contained, it being necessary to connect only seven leads to the controller. Where heavy currents are to be handled, cast grid resistance is employed, and unusual precautions have been taken to insure insulation which will be permanently satisfactory.

All contacts are mounted on a vertical slate face so that mill dust cannot settle between segments, causing short circuits. All contacts are of heavy copper and are reversible. The use of screws or bolts with special threads has been avoided, and so far as possible, wearing parts have been designed so that they can be manufactured by the user in his own repair shop.

The operation of all of these controllers is by a lever motion, which the manufacturers consider advantageous for crane and mill service. Although the cuts illustrate controllers for slip ring motors only, yet the Electric Controller & Mfg. Co. has furnished and is prepared to supply controllers for squirrel cage motors and alternating current commutating motors.

Rope Drive.

AT the Chicago plant of the Mechanical Rubber Co., formerly the Chicago Rubber Works, is in use an excellent example of a Dodge short-center rope drive connecting the two parallel line shafts driving the rubber-working mills.

Rubber-working mills or rolls are heavy power consumers. They are always set in two parallel rows, the mills of each row taking their power by direct gearing from a sub-floor line-shaft passing beneath. The steam engine is usually coupled directly to the end of one line-shaft. Then a train of heavy spur gears drove the secondary line from the primary.

As the lines must run in the same direction of rotation, the train of gears involved three wheels—the large driver and driven, equal in size, and an intermediate idler of smaller size, carried on a short shaft in its own independent bearings. Required to transmit high power at comparatively low speed, the gear train had to be heavy—and was correspondingly costly.

And the expense of installation was not all; the shocks of the work, as chunks of rubber might often be thrown into several of the mills simultaneously, caused frequent breakages of the teeth. The wear was rapid, even aside from the breakage, and renewal of gear was necessary at ridiculously short intervals.

The efficiency was low, as always with gearing in such service. The intermediate idler increased greatly the friction loss, because it not only doubled the friction and wear of tooth contact as compared to a two-gear train, but also introduced two bearings whose friction loss was that due to a pressure equal to twice the driving force at the teeth, plus the weight of the gear and its shaft.

This bearing pressure was less for a small intermediate gear than for a large one, not only because of the less weight, but also because of the reduced driving force at the pitch lines of the larger main gears thus permitted.

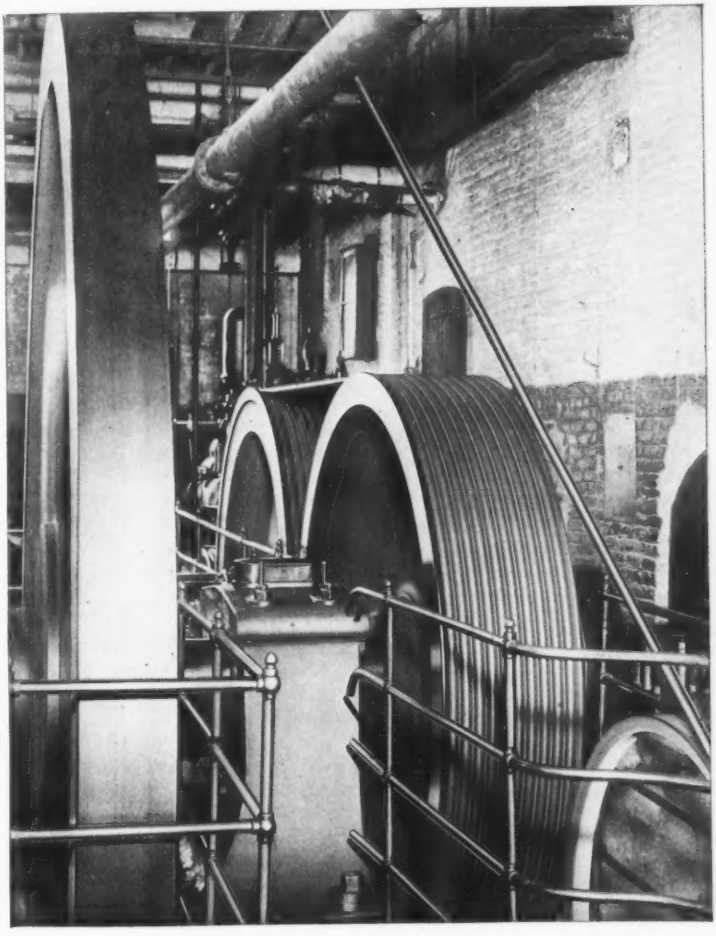
These gear trains gave much trouble and entailed large expense for operation and maintenance, yet they were used everywhere as the standard and only practically satisfactory way of connecting the two rubber-mill lines. It is interesting now to note that the Cleveland works of the Mechanical Rubber Co. was the first rubber-working plant to rid itself of the tyranny of these gears. That was in 1903, when the Dodge Manufacturing Co. installed in the reclaiming department there a rope which did away with the old difficulties and introduced a new era of satisfaction and efficiency to replace the noise, power waste and high maintenance costs of the former arrangement.

The perfect success of the Mechanical Rubber Co.'s innovation led other rubber workers to adopt the same plan. The Alkali Rubber Co., at Akron, O., came

second; then the Mechanical Rubber Co. had to have such a drive in the main mill at the Cleveland works. Since then many of the several rubber plants at Akron, and other concerns elsewhere, including the Chicago works of the Mechanical Rubber Co., have been similarly outfitted.

As a result, the old standard method of geared connection has given way to a newer standard of practice in this work—the Dodge American system of rope transmission, in special adaptation to the peculiarities of the service.

In all replacement cases the rope drives have gone readily into the same positions occupied by the gears. The elimination of the intermediate gear has permitted the use of larger drivers, so the two laboring sheaves have been made as large as the distance on center of the line-shafts would allow, leaving only



DODGE SHORT-CENTER ROPE DRIVE.

clearance space between the rims. Room for the tension carriage has always been found somewhere—beneath, overhead or outdoors.

The engine is a 26x48-inch Corliss, running 78 r. p. m., its shaft directly coupled to the primary line-shaft, which extends into the adjoining mill beneath the floor level. The secondary line is on the same level, at a distance of 109 inches on centers.

As the engine runs "over," the driving ropes of the Dodge drive are on top, and the slack is taken from below, over idlers, to the tension carriage housed in on the roof of the engine room.

The compactness of the rope drive may be seen by comparison of its size with the 18-foot flywheel on the engine. The photograph was taken with the drive in operation, and shows the steady running of the ropes. While nominally a 275-horse-power drive, there is ample overload capacity, as required for satisfactory operation in this service.

The drive was installed about four years ago, and has long since proved its exact fitness for the work, especially as compared to the gears which is replaced. This plant, therefore, is now equipped in conformity to the new standard in rubber-mill driving practice.

Reciprocating Meter.

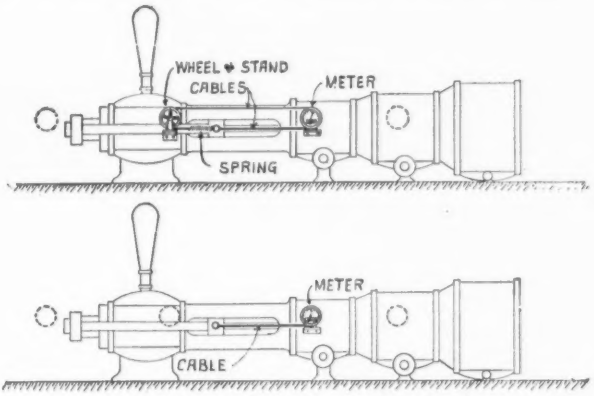
THE illustration herewith shows a meter for registering the total travel of reciprocating motions, making it suitable for pumps, engines, elevators, etc. The device is particularly useful for determining the actual life of different piston rings, packings, pump valves, lubricants, elevator cables and other appliances used on reciprocating machinery, as well as the amount of energy consumed where the duty performed is constant. The application of the meter to a pump is shown in the accompanying line drawing. A flexible bronze cable 1/8 in. in diameter is fastened to the drum on the meter and connected at the other end to the cross-head of the pump, which may have any diameter and any stroke up to 48 in. The meter is equipped with a spring return operating on the principle of a steam-engine indicator. The spring is made of phosphor bronze. The dotted circles indicate other locations for the meter, which may be used either right-hand or left-hand with lead of rope from either top or bottom of the drum. Any number of fractions of a stroke in either direction

DUENKEL RECIPROCATING METER.

are added and recorded by the main dial, which always rotates in a clockwise direction, one complete revolution representing 10 ft. of total piston travel. The reading is indicated to 1/20 part of a foot. The row of numerals at the bottom gives the total lineal feet traveled. This row of numerals repeats at 100,000,000 ft. For strokes longer than 48 in. a traction device of three pulleys is employed. The instrument can also be arranged for a positive return, the spring in this case being removed from the back of the meter. A second cable is led over the top of the drum to a small stationary wheel secured to the pump, engine, etc., and passing under the wheel is fastened to the cross-head by a small spring to keep the proper tension on the cables. One cable unwinds on the drum while the other winds in the same grooves.

From the readings in lineal feet the actual number of gallons of water and

the volumes of gas delivered by pumps and compressors can be calculated. This is important for boiler-feed pumps, where an accurate record can be obtained for the maximum weight of water or gallons evaporated per pound of fuel. On duplex pumps the meter shows which side is traveling the greater distance or is doing the most work, and gives notice if the valves have not been properly set. In determining the competency of an elevator operator, for instance, where electricity is used as the motive power, the instrument may be used to advantage. A good elevator operator will approach a landing and stop without going beyond the floor level. A poor operator will go beyond the floor level and then reverse and in one or two attempts manage to bring the elevator even with the landing. The starting of the elevator under such conditions requires an excess of energy. The elevator shafts being of known height, the travel in feet or miles per 100 trips should be constant, or very nearly so. By comparing the travel, as recorded on a meter of this type, of the various elevators in a building, the incompetent operators, those who go by a floor and then return in an attempt to stop at the landing, are quickly identified. The complete equipment comprises one meter proper with spring complete; one reserve main phosphor bronze spring; one coil of ⅛ in. diameter flexible bronze cable 30 ft. long; four small brass cable lamps; two back tension springs, one reserve; one stationary wheel with stand complete for positive drive, and one pipe collar in connection with positive drive. The device is made by the Mechanical Instrument Company, 120 Liberty Street, New York.



RECIPROCATING METER ATTACHED TO PUMP.

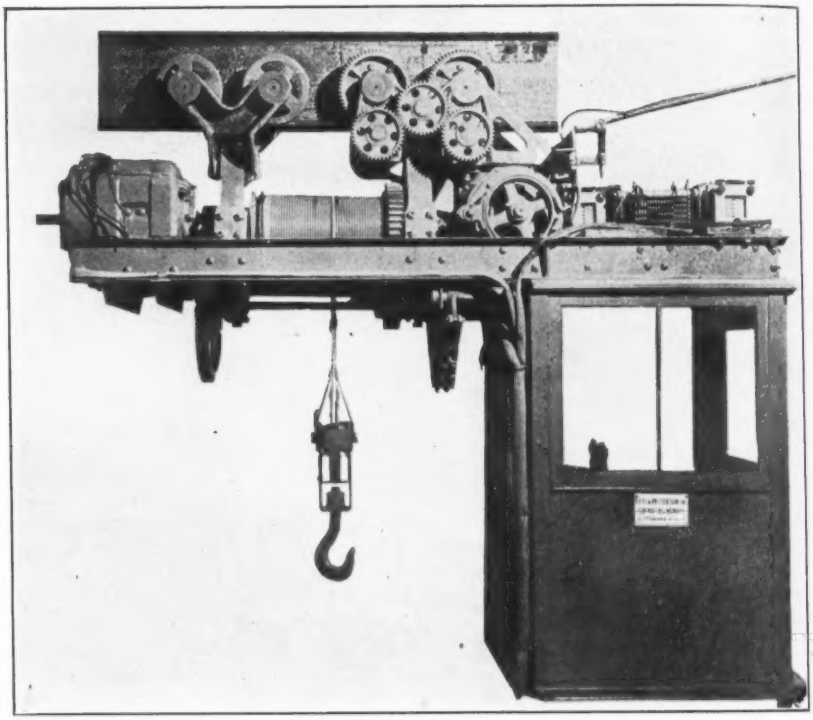
Monorail Trolley of New Design.

HEYL & PATTERSON, Inc., of Pittsburg, Pa., have recently installed a new monorail trolley at the plant of the A. M. Byers Company, Girard, Ohio. This trolley distributes coal to the boxes back of the puddling furnaces, from which it also takes the ash and cinder. It carries a two-ton bucket, the hoisting speed of which is 50 feet per minute. The trolley has a traverse speed of 350 feet per minute.

The trolley frame is hung from two cast steel trucks by means of two straps (steel forgings) resting on single ball bearings. This construction makes the trucks independent of each other and permits the trolley to round a curve with as small a radius as 11 feet. Each truck has four 10-inch cast steel track wheels, and all four wheels of one truck are driven by a 7½ H.P. type "K" Westing-

house motor connected through a spur-gear reduction to the countershaft, which drives each wheel through a bevel gear reduction. A band brake, which is operated by a foot treadle in the cab, is provided on the motor armature shaft to control the travel. It is to be especially noted that the travel wheels are set at such an angle as to be perpendicular to the slope of the flange of the 15-inch "I" beam on which they run; this, of course, reduces the wear on the wheels and the beam.

The bucket operating machinery consists of an 11 H.P. type "K" Westinghouse motor connected through a spur-gear reduction to a 12 inch drum. A band brake is provided on the countershaft to control the lowering speed and to hold the bucket stationary when the power circuit is open. Both the traverse and hoist motors are operated by means of rheostatic controllers.



HEYL & PATTERSON MONORAIL TROLLEY.

New Farwell Squeezer.

THE accompanying illustration shows a new type of Farwell squeezer designed to attach to the wall, instead of being mounted upon legs. This style of bracket was originally designed by Mr. K. J. Carroll, superintendent of the National Malleable Casting Company's foundry at Cleveland. This concern bought a large number of Farwell squeezers without legs and made their own wall brackets. Since that time The Adams Co., Dubuque, Iowa, makers of the Farwell squeezer, have had occasional calls for

a machine of this type, and so decided recently to add this type to their line.

The photograph shows a 30 inch machine, that is 30 inches between the side rods, but the bracket squeezer will also be built in 24 inch to 34 inch and 38 inch size. The principal advantage of this type is that it occupies very little space and where floors are crowded makes it possible to put up one or two more rows of molds.

This machine would, of course, be unsuitable for use on floors where considerable space is covered with molds and a day's work poured off at one time, but is just the thing for malleable foundries and others where a heat is taken off several times a day or pouring is continuous.

It should not be understood that this machine is to take the place of stationary Farwell squeezers or any of the other types, it being a special design suitable only for certain conditions. The proper machine for most foundries is the ordinary portable squeezer, which can be moved three or four times a day, thus saving a great deal of work in carrying moulds and moving sand. When floors are very narrow the broad gauge

NEW FARWELL SQUEEZER.

type of portable machine straddling the sand heap may be used, but this machine must be moved more frequently and necessitates a constant cleaning of the floor, so is not recommended where the reguar portable machine can be used.

The addition of these four sizes of bracket squeezers to the Farwell line brings the number of molding machines manufactured by the Adams Company up to 72 various styles and sizes. A machine of the bracket type was exhibited at the Detroit Foundrymen's Convention, June 6 to 10, together with twenty-seven of the other models.

Industrial Notes.

—Best Mfg. Co. of Pittsburg, Pa., have taken over the large plant at Oakmont, Pa., which was intended for the combined interests of the Crane Company of Chicago, and will operate it independently. They expect to move in by October 1st. They will manufacture valves and fittings such as they are making at the present time and will extend each line in such a way as to make products more formidable for the trade.

—The L. J. Wing Mfg. Co., 90 West street, New York, has recently sold the D., L. & W. R. R. Co. for their Bliss and Auchincloss collieries at Nanticoke, Pa., twenty-eight of their 20 inch "Typhoon" turbine blowers for forced draft on 3,500 H.P. of boilers.

—A combination of German and American capital has been effected to build a Balata belting factory in the United States. Although hundreds of thousands of feet of Balata belting are in service for transmisison purposes in the United States at the present time, none is manufactured in America. It is all put together in Germany or England. The corporation behind the new enterprise is the Victor-Balata and Textile Belting Company. The American interests represented in the new company are Charles E. Aaron and John R. Stein, president and treasurer, respectively, of the New York Leather Belting Company of New York City. The German interests are represented in the new company by William Vollrath, Albert Vollrath and Edwin Vollrath of the firm of C. Vollrath & Son of Blankenburgh, Germany. The officers of the new company are Charles E. Aaron of New York, president; Edwin Vollrath of Blankenburgh, Germany, secretary, and John R. Stein, New York, treasurer.

—The building of the new plant will entail an expenditure of half a million dollars in buildings and equipment and will be located at Easton, Pa. Work on the first two buildings of the new plant will be begun immediately. The factory site covers nine acres of ground and is located to the westward of Easton in a suburb known as Palmer. Two buildings to be erected immediately include the main factory building, 150 x 100 feet and an impregnation building 75 x 60 feet. Both buildings will be constructed of concrete and structural steel.

—Among the recent orders received by the Nernst Lamp Company were four from the wholesale department of Marshall Field & Company, Chicago, aggregating 888 glower units. All of the lamps are of the multiple glower type and special finished housings are used. This firm installed its first Nernst lamps in December, 1907, the same year of the installation of 12,000 glower units in the retail store of Marshall Field & Company, and has frequently since placed orders for Nernst lamps to replace other lamps.

—Mr. S. Watts Bowker, Machinery Club, New York, for the past three years a director and general sales manager of the Central Foundry Company, has withdrawn from that company, and on his retirement expresses appreciation to his friends and to the trade for their support and friendly personal co-operation during his tenure.

—The new steel car works of the Pullman Company at Pullman, Ill., will be supplied with light and power by two 1,000-kilowatt Westinghouse high-pressure steam turbines. The steam elements

of these units will operate at 150 pounds pressure, exhausting into a vacuum of 28 inches, maintained by Westinghouse-Leblanc condensers. The principal service rendered by the new equipment will be the generation of power for the manufacture of steel cars, which is to be carried on upon a large scale in the new plant of the Pullman Company.

—For supplying power to the brick-making machines in its new brick plant at Carlyle, Kansas, the Lumbermen's Portland Cement Company has installed two Westinghouse vertical gas engines of 200 and 140 horse-power capacity respectively. These engines use as fuel natural gas from the company's wells. Direct connected to the gas engines are a 150- and a 100-kilowatt Westinghouse alternating current generator, which furnish three-phase, 25-cycle power at 440 volts for the motor-driven brick-making machinery.

—The Glidden Varnish Company Ltd., was organized in Canada March 2, 1910, this company having purchased the plant, business, and good-will of Blackwell Varnishes, Ltd., at Toronto, Ontario, Canada. The plant is now being remodeled and the capacity largely increased, in order to handle better the trade of the Glidden Varnish Company of Cleveland, Ohio, of which the Canadian plant will be a branch, at which all the Glidden products will be manufactured, including Jap-a-lac, concrete finishes and waterproofings.

—The firm of Dodge & Day, engineers, Philadelphia, have been retained by the Reliance Electric & Engineering Company, Cleveland, Ohio, to prepare preliminary plans and recommendations for a new plant which this company is about to build. The Reliance Electric & Engineering Company manufacture the Lincoln variable-speed motor, the success of which has required for its manufacture extensive additional quarters. It is the intention to make the new plant a model layout in every respect and to use the shop as a showroom, showing the motors in operation.

—The Boston Belting Co. announce that their arrangements with the Jewell Belting Co. of Chicago to act as Western agent have been terminated, and they have opened a store at 177 Lake street, Chicago, with Mr. M. S. Curwen, manager of sales, in charge of the same. They will carry in Chicago an even more complete assortment of rubber belting, hose, packings and other mechanical rubber goods than in the past.

Mr. Benjamin K. Hough has been appointed Boston sales manager for the Wisconsin Engine Co., Corliss, Wis. He will have offices in the Oliver Building, Boston, and represent them in the sales of their apparatus in the New England states.

—The Robins Conveying Belt Company report extraordinary progress in the way of new business within the last few months. Mr. Thomas Robins, the founder, and as president of the company, states that the company has done as much business in the last three months as it did during the entire year of 1909. The Robins Conveying Belt Company makes the conveyor bearing its name. They are also manufacturers and contractors of a variety of material-handling machinery and have constructed some of the largest handling plants in the world.

—The Ingersoll-Rand Company is about to install a complete compressed-air equipment for the Geo. W. Jackson Company, of Chicago, for their contract on Section 54 of the Catskill Aqueduct at Yonkers. The order covers compressors, drills, mountings and air reheaters.

—Mr. Henry D. Shute was appointed to the position of acting vice-president of the Westinghouse Electric & Manufacturing Company as of April 1, 1910. For seventeen years Mr. Shute has been associated with this company, and his promotions from time to time have been of a character to give him a broad experience in shop, sales and executive work. Mr. Shute studied electrical engineering at the Massachusetts Institute

of Technology, from which he was graduated in 1892. Following his graduation, he spent a year in study in Germany at the School of Mines, Clausthal, and also in Dresden. It was in 1893 he entered the works of the Westinghouse Company at Pittsburg as an apprentice, spending his first two years in the testing department, following which he spent considerable time on erection work, on laboratory work, under Mr. C. F. Scott, and later as assistant foreman of one of the departments of the works. This naturally gave him a broad experience in shop work, which, with the designing work on alternating-current apparatus, which he subsequently took up in the engineering department, enlarged his experience still more. After five years' service with the company, Mr. Shute took up work in connection with the sales department at the East Pittsburg office, and in 1901 was made the head of the alternating-current division, correspondence department. Two years later he was advanced to the position of assistant to Vice-President L. A. Osborne, which position he held at the time of his recent appointment. In this latter position he was active in the developments made in heavy electric traction and particularly in single-phase railway work.

—The B. M. Osbun Company, with offices in the Commercial Bank Building, Chicago, Ill., has been appointed by the Abendroth & Root Manufacturing Company of Newburgh, N. Y., as their representative covering the Chicago territory for the sale of Root spiral riveted pipe and Root water-tube boilers. These products have been on the market for over forty years and are in service in nearly all parts of the world. Some recent installations in prominent buildings are the exhaust steam lines for the new Singer Building and for the City Investing Building, in New York City. Large quantities of this pipe in various sizes have been used for the compressed-air lines during the construction of the tunnels under the Hudson and the East rivers; also for water pipe for the new filtration plant known as the Torresdale system for the City of Philadelphia, Pa. Both boilers and large quantities of their spiral riveted pipe have been shipped at various times and are in service in the construction of the Panama canal.

—The Mattapan Consumptives Hospital, of Mattapan, Mass., is to be ventilated by motor-driven fans built by the Massachusetts Fan Co. Both the cased type and the Davidson propeller type are to be used.

—A little while back, the Dixon Company, for the first time in eighteen years, took up a belt in one of its mill rooms. For eighteen years about thirty belts in that room have been running constantly; the belts are about twenty-five feet in length and six inches in width. There is a great deal of graphite dust in the room, yet these belts have run satisfactorily without breakage or without being taken up for eighteen years. The belts are regularly treated with Dixon's Traction belt dressing.

—Dodge & Day, engineers, Philadelphia, have been retained by the Niagara Machine & Tool Company of Buffalo in connection with the layout of a new plant which this company will build upon the site they recently acquired on the Belt Line Railroad. The new plant will include a modern machine and erecting shop, stores building and an office building. As soon as these are completed and fully occupied, the company expects to undertake the construction of additional buildings to accommodate the work, which for the time being will be continued in their present quarters.

—Taylor gravity underfeed stokers, manufactured by the American Ship Windless Co., Providence, R. I., are to be installed by the following for the specified boiler horse powers: Lowell Electric Light Corp., Lowell, Mass., one 7-retort stoker for a 600-H. P. B. & W. boiler; Metropolitan Street Railway, New York, two 3-retort stokers for 250-H .P. B. & W. boilers; City of Grand Forks, N. D., one 3-retort stoker for a

250-H. P. Freeman boiler; Dallas Electric Light & Power Co., Dallas, Texas, two 7-retort stokers for 500-H. P. B. & W. boilers; Detroit Public Lighting Commission, Detroit, Mich., two 4-retort stokers for 400-H. P. Stirling boilers; Lake City Power & Lighting Commission, Lake City, Minn., one 3-retort stoker for 250-H. P. Stirling boiler; and through their New York agents, the Lenher Engineering Co., two 2-retort stokers for heating furnaces at the Solvay Process Co., Detroit, Mich.

—The Harrison Engineering Co., New York, have just received the contract to install a complete heating and ventilating system for the seven-story loft building at 586 Fifth avenue, New York. In this building, which is to be occupied by A. Lowenbein's Sons, is a Harrison Aertube heater. The air for heating and ventilating will be heated by passing through the tubes of the Harrison Aertube heater. The U. S. Light & Heating Co. have contracted with the Harrison Engineering Co. for the heating and ventilating of their plant at Niagara Falls. The five buildings are to be heated throughout by Harrison Aertube heaters. Producer gas will be burned for fuel, and the heaters will utilize the waste heat from the many lead-melting furnaces. The air, of which 120,000 cubic feet will be supplied per minute, will be distributed throughout the entire five buildings by special electric cone fans.

—Mr. H. F. Stimpson, consulting engineer, 1 Madison avenue, has removed his office to the Singer Building, having become associated with the Universal Audit Company as its chief engineer, in charge of the design and development of efficiency in industrial plants. Mr. Stimpson has had a wide experience as an engineer, extending over more than twenty-eight years, having been previously connected with many large organizations, among which are the General Electric Company; Dodge & Day, engineers, Philadelphia; the Roberts & Abbott Company, engineers, Cleveland, Ohio, and the Emerson Company, efficiency engineers, of New York. He is also one of the lecturers in the very advanced course in manufacturing plant design at Columbia University. The general manager of the Universal Audit Company, Mr. W. M. Williams, has had a wide experience in the organization of industrial corporations, gained by association with men engaged in the formation and successful management of several large enterprises, among which were the American Steel and Wire Company, the American Steel Hoop Company and the American Can Company. This organization, which has a capital of $150,000, is unique in that it is the first one to cover the entire field of commercial and technical organization and service required by present-day industrial concerns, and to so combine the financial and economic accounts with efficiency standards as to demonstrate the efficiency of the management together with obtained financial results.

—The Kerr Turbine Company of Wellsville, N. Y., has arranged for representation in two more American and three foreign cities as follows: San Francisco and Oakland, Cal., United Iron Works; London, Eng., Economical Gas Appliance Construction Co., Ltd.; Mexico City, J. H. Bloomberg; Sidney, N. S. W., A. F. Partridge. With the above the Kerr Turbine Company now has active representatives in twenty-six cities. The use in Europe of American turbine units of the small sizes built by this firm would hardly seem to warrant representation on the other side, but numerous Kerr turbines have been sold in England alone, one customer there having bought seven on repeat orders.

—The Pittsburg Contracting Company have placed an order with the Ingersoll-Rand Company for an equipment of air compressors and rock drills for their work on Section 53 of the Catskill Aqueduct, New York.

NEW CATALOGUES AND TRADE PUBLICATIONS.

These catalogues may be had free of charge on application to the firms issuing them. Please mention The Engineering Magazine when you write.

Air Compressors.

INGERSOLL-RAND CO., 11 Broadway, New York.—Bulletin No. 3023 describing in detail Class "OC" duplex Corliss steam-driven air compressors.

Blowers.

AMERICAN BLOWER CO., Detroit, Mich.—A booklet entitled "Blower Equipment for the Modern Foundry," illustrating heating apparatus, ventilating plants, cupola blowers, mechanical draft outfits, blast equipment, forge blowers, etc.

MARINE BOILER WORKS CO., Toledo, Ohio.—A well-illustrated catalogue of marine and stationary boilers, water jackets, oil stills, agitators and condensers, steel converters, stacks, tanks and riveted pipe.

Centrifugal Pumps.

DE LAVAL STEAM TURBINE COMPANY, Trenton, N. J.—Catalogue "B," being a very complete exposition of De Laval high-efficiency centrifugal pumps, with remarks on the principles of design and upon their selection for various services. This should be a very useful catalogue for consultation and reference.

Chain Drive.

MORSE CHAIN CO., Ithaca, N. Y.—It is claimed that high-speed chain provides an ideal method of gearing transmission with application on any convenient centers, noiseless action, high efficiency, ease of application, the flexibility of belting, and the positive speed ratio of gearing. It is applicable not only to machine tools, but for general power transmission.

Contractors' Machinery.

CONTRACTORS' SUPPLY & EQUIPMENT CO., 1645-1647 Wazee St., Denver, Colo.—General Catalogue illustrating contractors' machinery, tools, and supplies.

Cranes.

EUCLID CRANE & HOIST CO., Euclid, Ohio.—Pamphlet describing Euclid electric and hand-power traveling cranes, electric hoists and jib cranes, overhead trolley systems and trolleys.

Cupolas.

NORTHERN ENGINEERING WORKS, Detroit, Mich.—Catalogue describing the Newton cupola and discussing its advantages for rapid continuous melting, high-fuel economy, saving in wear on lining, and wide range of work.

Incandescent Lamps.

GENERAL ELECTRIC COMPANY, Schenectady, N. Y.—Bulletin No. 4739, describing the GE Mazda incandescent lamp, which has an improved tungsten filament and gives the high efficiency of 1 to 1¼ watts per candle. In other words, as compared with the carbon lamp, the Mazda lamp divides the cost of current by three, or gives three times as much light for the same expenditure of money.

Indicators.

PRECISION INSTRUMENT COMPANY, 49 Larned St., Detroit, Mich.—Portfolio of pressure and vacuum indicators and recorders for steam, gas, water, or air. This is the line of instruments manufactured in England by Alexander Wright & Co., Ltd.

Mechanical Stokers.

CHAS. N. HAYS CO., 1007 Empire Bldg., Pittsburg, Pa.—Illustrated booklet describing Type A Vulcan mechanical fuel feeders for smokeless economical combustion and low-grade fuels.

Pulverizers.

JEFFREY MANUFACTURING CO., Columbus, O.—Catalogue No. 31C of the Jeffrey crushers and pulverizers.

Pumping Engines.

LUITWIELER PUMPING ENGINE CO., 123 Ames Street, Rochester, N. Y.—Illustrated catalogue of the Luitwieler system of non-pulsating pumps for city and village water works, railroads, tank service, boiler feeding, hydraulic elevators, mines, manufacturing, refrigerating and all service for which pumps are used.

Recording Thermometers.

TAYLOR INSTRUMENT COMPANIES, Rochester, N. Y.—Advance sheet of "Tycos" recording thermometers.

Transmission Machinery.

WEBSTER MFG. CO., 2410-2432 West 15th St., Chicago.—General Catalogue No. 35 of more than six hundred octavo pages, illustrating and describing in great profusion a complete line of transmission, conveying, and elevating machinery.

THE CURRENT RECORD OF

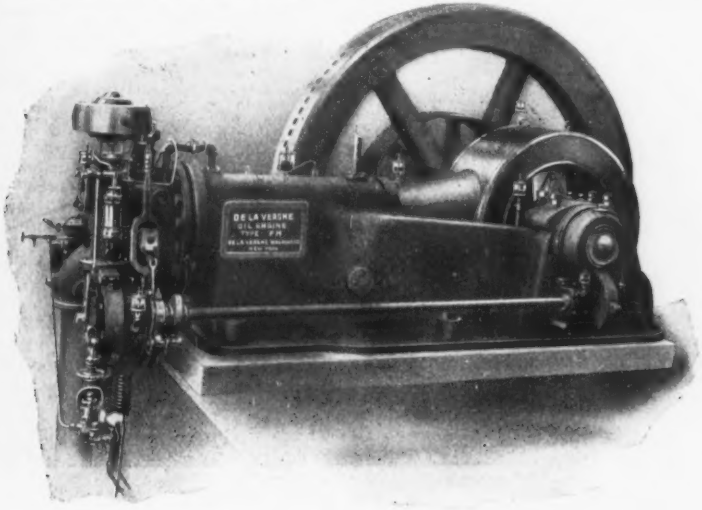
IMPROVED MACHINERY

NEW METHODS NEW MATERIALS

NEW APPLIANCES

The De La Vergne Engine Company. THE accompanying illustration shows the De La Vergne engine Type "F. H.," made in sizes of 85 H. P. to 350 H. P. The builders offer these engines subject to a guarantee that when operating at sea level with crude oil, distillate, or cheap fuel oil, 16° Baumé or better, they will develop continuously their full rated horse-power, the same to be measured on the wheel shafts.

The advantages claimed for this engine are : (1) Low fuel expense. Under the ordinary conditions generally existing, and the usual ruling prices of coal and fuel oil, the fuel expense of this engine is the lowest available, taking into account even steam turbines of large capacity. (2) Simplicity. The engine, compressed air apparatus for starting, small water circulating system and the oil storage tank constitute the



DE LA VERGNE TYPE "F. H." OIL ENGINE.

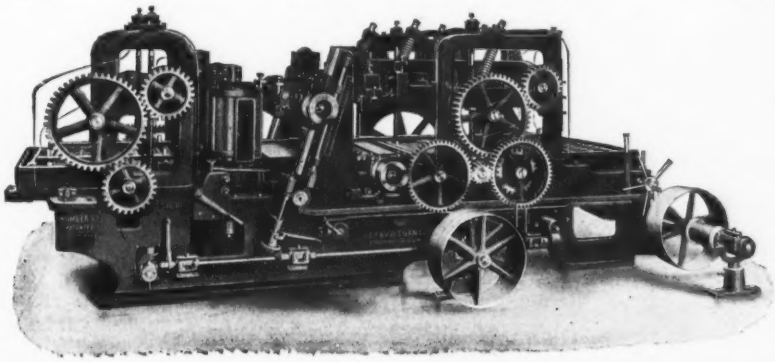
entire plant, as against a high-class steam plant with boilers, pumps, heaters, economizers and complicated condensing apparatus. (3) No stand-by losses. When the engine is shut down and the oil supply valve closed, operating expense ceases until ready to start again. (4) Minimum attendant charge. A licensed engineer is not required to operate this engine, nor is there need for firemen or other helpers. A small part of the time of one man constitutes the whole labor charge. (5) No handling of coal or removing of ashes. The fuel oil is preferably handled by gravity, direct from the tank car from which it is received from an underground storage tank, from which it is pumped by the engine itself. No refuse of any kind is produced from the operation of this engine. (6) Absence of excessive pressure in engines. High pressures mean frequent breakages and shutdowns. It is claimed that the average maintenance charge with this engine is less than with the steam engine. The builders, the De La Vergne Machine Co., New York City, have issued Bulletin No. 101, illustrating and describing type "F. H." oil engines in detail and it will be sent free on request.

The Hauck Burner.

THE accompanying illustration shows the Hauck burner, a device for the transformation of crude oil and compressed air or oxygen into a heavy body of gas, resulting in complete combustion. These results are obtained by placing crude, fuel, or kerosene oil in a tank under pressure of from 15 to 100 pounds per square inch, connecting the

THE HAUCK BURNER.

oil tank with a line of tubing which conveys the fuel oil to the burner, where it is formed into a heavy gas, giving a strong, blue flame, and a most intense heat. The manufacturers draw attention to the custom of some makers of burners to measure their machines by the length of the flame. The Hauck burner obtains complete combustion, giving a comparatively short and powerful flame; it is, therefore, absolutely safe and does not endanger the shop or workmen. The Hauck Manufacturing Co., 140 Livingston street, Brooklyn, have issued a bulletin entitled "Series 30," showing many instructive illustrations of the use of the Hauck burner for locomotive and steel car repairs, in boiler shops, for flanging or off-setting, pipe bending, in machine shops, and shipyards and a combination forge.



HEAVY DOUBLE CYLINDER TIMBER DRESSER.

The Heaviest Timber Dresser.

WE present herewith a new and improved machine for meeting the demand of large lumber mills, car shops, shipyards and other places where large timbers are worked and where they require a powerful machine with roll feed, able to plane and joint dimension timbers on four sides, at one operation. It is also adapted for every variety of heavy surface planing. This No. 125 double cylinder timber dresser is said to be the most powerful timber dresser ever built. The frame is of massive construction, has plate sides, and is well braced to prevent vibration when working to its full capacity. It will plane long timbers on two or four sides up to 30 inches wide and 16 inches thick, or two sides and one edge of two timbers 13 inches wide and 16 inches thick. The feeding mechanism on this machine is one of the finest and most improved ever placed on a tool of this kind. It consists of six 8-inch rolls, the two upper rolls at the feeding-in end being divided and center geared, insuring a very powerful drive. The rolls are carried in heavy housings mounted on a saddle, raising and lowering by power for different thicknesses. The feeding-out roll is geared on both ends and mounted in a heavy housing carried on a saddle which slides on the stands. Pressure is applied to roll by means of two double volute springs. All upper rolls are geared to drive down, insuring a very powerful feed. For further information concerning this machine, you are requested to write the manufacturers, J. A. Fay & Egan Co., 212-232 West Front street, Cincinnati, Ohio.

Monel Metal.

The alloy recently introduced by the Orford Copper Company, known as "Monel Metal," is rapidly becoming a leading non-corrosive metal, and much interest in its physical properties is now being evinced by the metal trade. Monel Metal is a natural alloy of copper and nickel in which nickel predominates (nickel 68%). As the alloy is made directly from the ore without separating the constituent metals, there results an intimate mixture such as is difficult to obtain in the usual method of producing alloys.

In appearance, Monel Metal cannot be distinguished from pure nickel and takes the same finish. Its great strength, together with its extreme non-corrosiveness, adapts it for uses for which an alloy has long been sought and for which there is a constantly increasing demand in marine work for parts that come in contact with salt water or waters that cause corrosion. The United States Government is specifying Monel Metal for construction work under the Navy Department, for such parts as propellers, pump linings and pump rods.

While the physical properties of this alloy excel those of mild steel, still it machines very easily. A lathe can be run at the same speed on Monel Metal as on mild steel. The metal can be forged, soldered, brazed or electrically welded. The great strength of Monel Metal, combined with its high ductility and non-corrosiveness, admirably adapts it for use where the non-corrosiveness of a bronze together with the high strength of steel is desirable. Monel Metal rods in service have shown no scoring in instances where bronze and steel were rapidly cut out. Repacking is reduced to a minimum and this fact, together with its resistance to alternating stresses, make it the best metal known for pump and piston rods.

Monel Metal is now commercially produced in a variety of forms, such as ingots, sheets, rods, wire and castings.

Owing to its high melting point, special equipment and some experience with the metal is necessary in order to produce castings successfully.

The Bayonne Casting Company, Bayonne, N. J., makes a specialty of casting Monel Metal and now produces such castings as propeller wheels, marine fittings, acid handling apparatus, exhaust fans for acid gases, pumps, plungers, valve seats, rods, gears, and pickling apparatus; in fact, any casting which should combine great strength with non-corrosiveness. The castings are sound, clean, true to pattern. They can be readily machined, forged and electrically welded.

Special Feed Water Heater for Condensate and Returns.

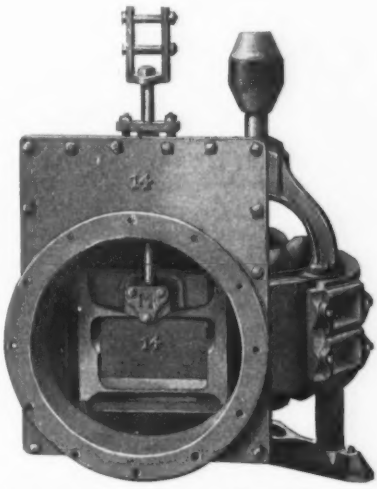
WHERE condensate from a surface condenser or returned from heating or drying systems form a considerable part of the boiler feed supply, it is often necessary to make up the full amount of feed water required by the boiler by adding water which is of a scale-forming or corrosive nature. On account of the disproportionately large cost of putting in a softening system of the usual type for this small amount of water it is usually fed to the boilers without treatment, with the result that scale is formed in the boilers. While the scale so formed is less than the amount that would be deposited if raw water alone were used for the boiler feed supply, the scale is, on the other hand, apt to be hard, and, because of its slow formation, apt to be overlooked, resulting frequently in the unexpected burning of plates and tubes, leakage at seams and tube ends, etc. This problem has been attacked by the Harrison Safety Boiler Works, 3138 North 17th street, Philadelphia, Pa., in their Engineering Leaflet No. 7, entitled "Combination Feed Water Heaters and Softening Sys-

tems," which describes an apparatus designated for plants in which such conditions obtain. This apparatus differs from their Sorge-Cochrane hot process system in that provision is made for heating the two separate water supplies independently, and for treating only one with a reagent. The condenser discharge or other returns, after passing over heating trays, pass directly to the pump supply chamber or pure water compartment, whereas the raw water, after heating and mixing with the reagent, falls into a spacious sedimentation chamber and afterwards passes through a filter bed before entering the pure water compartment. To insure a continuous supply of water to the boilers in case of clogging of the filters, there is an automatic by-pass which, in case the level of the water in the pump supply chamber should fall below a certain level, will supplement with sufficient hot, treated water to supply the pumps. In a hot process system, the "temporary" hardness, or carbonates, are precipitated by heat, and the only reagent required is that needed for the transformation of "permanent" hardness, such as sulphates, chlorides, nitrates, acids, etc. Due to the use of only one reagent, the management of the apparatus is much simplified, no complicated chemical analyses being required, as where two reagents must be proportioned to the varying requirements of the water. The apparatus has the further great advantage over a cold process system that it performs, in addition, the functions of the feed water heater which should be installed in any case. For this purpose it can be adapted to any of the various forms assumed by open feed water heaters, that is, it can be used as heater and receiver in connection with an exhaust steam heating system, etc. This pamphlet should prove of interest to all engineers having to do with steam plants where scale-forming water is encountered.

The Phoenix Little Giant.

THE Phoenix "Little Giant" turbine wheel is a double wheel, the lower part being independent of the upper part, both parts being keyed to the same shaft; or, strictly speaking, two wheels with their backs together on the same shaft, one discharging downward and the other upward.

The scroll of this wheel is cast in one piece and is fitted with hand holes, which gives ready access to the wheel to remove obstructions without detaching the spout or disturbing the wheel.



THE PHOENIX "LITTLE GIANT" TURBINE WHEEL.

The gate box is of cast iron, bolted firmly to the case. The surface of the gate is planed, also the seat or ways upon which it slides. The pressure of water will always keep them together, and as both surfaces are planed and straight, they will always keep tight.

The gate stem is turned its entire length and moves perpendicularly through a stuffing box on the top of

gate frame. The stuffing box is filled with packing to avoid leakage around the gate stem.

These wheels are furnished with and without division plate. The division plate separates the upper and lower sections of the wheel, so in case of a scarcity of water the gate of wheel can be raised to this division plate, using one-half of wheel and one-half the quantity of water and at the same time get within 2 per cent of as good percentage of the power used as when using the whole wheel.

By the curved or hooked shape of the bucket, curving towards the stream, the water has a steady unbroken flow from the time it enters the wheel until it is discharged. The water in the scroll, by entering the wheel with a greater velocity than that with which the wheel is moving, imparts to it greater force. The shape of the bucket where the water enters is such that the water moves in the same direction as the motion of the wheel, and therefore the friction of water against the bucket at this point is helping instead of retarding the power; hence an advantage over wheels where the friction acts in opposite direction to the motion of the wheel. The friction at place of discharge is the same as in most other wheels—that is, in opposite direction to the motion of the wheel—but this wheel being seven-tenths the diameter, the friction has only seven-tenths the leverage, and has only seven-tenths the surface to wear between the periphery of the wheel and case, consequently only seven-tenths the leakage. For instance, a Phoenix Little Giant wheel, fourteen inches in diameter uses the same amount of water and gives the same amount of power that a "first-class flume wheel" would give from twenty to twenty-four inches in diameter.

Further particulars of this wheel may be had from Munson Bros. Co., Utica, N. Y.

Personal.

—Lucius I. Wightman, for the past six years advertising manager for the Ingersoll-Rand Company, 11 Broadway, New York, has resigned his position, the resignation taking effect August 1. He will open an office in New York as an independent specialist in machinery advertising, handling the accounts of manufacturers of machinery and engineering products. Mr. Wightman brings to his new enterprise qualifications peculiarly fitting him for this line of work. To his long experience in managing one of the largest advertising accounts and publicity departments in the machinery field, he joins a prior experience of years in practical mechanical and electrical engineering, construction work, machine design and manufacture, and machinery selling. He is a graduate engineer, the author of a text-book on compressed air, and an authority on compressed air subjects.

—Sylvester S. Howell has become associated with Paul M. Chamberlain, engineer, Marquette Building, Chicago, under the firm name of Chamberlain & Howell. The firm will carry on the designing and consulting engineering practice established by Mr. Chamberlain.

Industrial Notes.

—On account of its constantly increasing business as a newspaper and magazine advertising agency, the Franklin P. Shumway Co., 373 Washington street, Boston, Mass., has found it necessary to enlarge its facilities. This agency was founded by Franklin P. Shumway thirty years ago and numbers among its many clients such firms as the American Hide & Leather Co., Bigelow Carpet Co., Bradley Pulverizing Co., Gurney Heater Manufacturing Co., Knox Automobile Co., the Pacific Mills, and M. Steinert & Sons Co.

—Northern Engineering Works, Detroit, Mich., crane builders, report that they have recently installed in the power stations of the Tunnel and Terminal

Ry. Co., of New York, two 25-ton, 40-ft. span traveling Northern Cranes, and one of 10 tons capacity.

—Arrangements have been made by the C. W. Hunt Company, New York, builders of coal handling, conveying and hoisting machinery, by which their business on the Pacific Coast will be handled by the San Francisco Bridge Co., with offices at 865 Monadnock Building, San Francisco. The company has just completed a naval coaling station in San Francisco Bay for the U. S. Government.

—The Magnolia Metal Co., 118 Bank street, New York, offer a practical engineer pocket-book brought up-to-date, containing 680 pages and treating on over 2,000 mechanical and engineering subjects. It is offered at the very low price of 40 cents, postage prepaid to all parts of the United States, Canada, and Mexico, or wherever postage on it does not exceed domestic rates.

—The Red River Power Company of Grand Forks, N. D., has announced substantial reduction in gas and electric rates and that improvements aggregating upwards of $100,000 will be made this season. The Red River Power Company is the new name of the Grand Forks Gas & Electric Company which was purchased recently by H. M. Byllesby & Company of Chicago. The principal improvements outlined include the installation of a 750 K.W. engine generator unit, the construction of from 20 to 25 miles of electric pole line distributing system through the residence district, the construction of nearly four miles of new four-inch gas mains, and special inducements to obtain additional consumers of gas and electricity. In the past there has been practically no electric service for residences in Grand Forks.

NEW CATALOGUES AND TRADE PUBLICATIONS.

These catalogues may be had free of charge on application to the firms issuing them. Please mention The Engineering Magazine when you write.

Asphalt Road Beds.

American Asphaltum & Rubber Co., 234 Michigan Ave., Chicago, Ill.—An instructive pamphlet entitled "Good Roads," describing how roads are made dustless, durable, waterproof, and free from mud, ruts, and holes, by the use of "Pioneer" road asphalt, about 236 gallons to the ton.

Automatic Engines.

Skinner Engine Co., Erie, Pa.—A very complete catalogue describing the Skinner engine, and calling attention to the distinguishing features of steam-tight valve economy, practically absolute regulation, automatic oiling and purifying system, and accessibility and reliability.

Electric Hoists.

Sprague Electric Co., 527-531 W. 34th St., New York.—A small catalogue showing very many applications of Sprague electric hoists in a great variety of sizes and designs.

Engines.

Providence Engineering Works, Providence, R. I.—Bulletin No. S-75, most thoroughly illustrated and giving full details of Rice & Sargent Corliss engines. There are included many photographic illustrations of engines installed.

The Russell Engine Co., Masillon, O. —Illustrated catalogue of the Russell single-valve horizontal side-crank "Enclosed" engine. The present pattern is the result of thirty-five years of experience in building this type of engine.

Friction Clutches.

The Hill Clutch Co., Cleveland, O.—Catalogue No. 8 describing in detail the various types of the Hill friction clutch.

Gas Engines.

Turner-Fricke Manufacturing Co., Sharon, Pa.—Catalogue illustrating and describing the Turner-Fricke gasoline engines.

Hoisting Machinery.

C. W. Hunt Co., West New Brighton, N. Y.—General catalogue No. 102, illustrating and describing briefly, but with sufficient information, coal handling and hoisting machinery, conveyors, industrial

railways, electric locomotives, electric and steam hoists, and Manila rope.

WELLMAN-SEAVER-MORGAN CO., Cleveland, O.—A very handsome catalogue illustrating a complete line of hoisting machinery and an interesting equipment shown has the double reel hoist direct connected to a 500 H. P. d. c. motor.

Leather Packings.

DETROIT LEATHER SPECIALTY CO., Beecher and Michigan Aves., Detroit, Mich.—A new catalogue in two colors illustrating leather packings designed for hydraulic presses, hydraulic jacks, hydraulic elevators, hydraulic controlling valves, pneumatic hoists, pneumatic drills, mining machinery and punches, artesian well cylinders, Corliss engines, cotton compressors, etc.

Motors.

SPRAGUE ELECTRIC CO., 527-531 West 34th St., New York City.—Bulletin No. 600, illustrating and describing in much detail single and poly-phase induction motors.

Oil Filters.

BURT MFG. CO., Akron, Ohio.—A very handsomely illustrated descriptive catalogue showing an extensive line of oil filters, exhaust heads, and ventilators. An interesting form is the Burt glass-top ventilator, constituting both a skylight and a ventilator at the same time, in many cases making it unnecessary to provide for any other form of skylight. If the weather conditions make it advisable at times to close the ventilator it may be entirely closed without in any degree obstructing the passage of daylight through it.

Ore Handling Machinery.

THE BROWN HOISTING MACHINERY COMPANY, Cleveland, O.—A catalogue consisting entirely of a number of illustrations of ore and coal handling plants.

Recording Instruments.

BRISTOL CO., Waterbury, Conn.—Booklet of 64 pages, being in the nature of an illustrated index of Bristol's recording instruments for pressure, temperature, and electricity. The book is not in the nature of a catalogue, but simply a series of illustrations of the most important Bristol instruments with partial explanantions of them and their applications. Bulletins cataloguing the various instruments separately have been published and will be furnished on request.

Recording Thermometers.

BRISTOL CO., Waterbury, Conn.—Bulletin No. 124 relating to Bristol recording thermometers. One thermometer shown is for use in residences for continuously recording the outside atmospheric temperature.

Reinforcing.

AMERICAN SYSTEM OF REINFORCING, Chicago, Ill.—Descriptive catalogue of the American system of reinforcing consisting of spirals for columns, frames for girders and beams, and fabric for floors and roofs.

Reinforced Concrete Pipe.

REINFORCED CONCRETE PIPE CO., Jackson, Mich.—Elaborate catalogue illustrating an extensive line of reinforced concrete pipe for sewer construction.

Rib Metal.

TRUSSED CONCRETE STEEL CO., Detroit, Mich.—Descriptive catalogue of rib metal consisting of a series of straight ribs rigidly connected by cross ties formed from the same sheet of steel used in floors, roofs, walls, arches, sewers, etc.

Steam-Turbine Generators.

GENERAL ELECTRIC CO., Schenectady, N. Y.—Attractive publication entitled "Curtis Turbine Installations," containing upward of fifty photographic views of installations of Curtis steam-turbine generators of various capacities.

Steel Belt Pulleys.

THE AMERICAN PULLEY CO., Philadelphia, Pa.—A small catalogue illustrating the American steel split pulley. The mechanical construction is such as to admit of a light rim of one-ply made exceedingly stiff by interior flanges to which the arms are attached, and by heavy rolled beads at the edges of the face.

Tools and Parts.

NATIONAL-ACME MFG. CO., Cleveland, Ohio.—An unusually well arranged catalogue of tools and parts of the Acme automatic multiple spindle screw machine.

Valves and Steam Specialties.

OHIO BRASS CO., Mansfield, Ohio.—Catalogue H, illustrating the Ohio radiator valves, union elbows, globe, angle, and check valves, pressure regulating valves, and steam specialties.

Valve Specialties.

G. M. DAVIS REGULATOR CO., 422 Milwaukee Ave., Chicago, Ill.—Extensive catalogue of valve specialties for power-plants and heating systems.

Water Softener and Purifier.

DODGE MFG. CO., Mishawaka, Ind.—Hangers illustrating the Eureka water softener and purifer, one showing an exterior view and another a sectional view. The latter is illustrated in colors and, besides showing most clearly the action of the apparatus, is an unusually fine specimen of the engraver's art.